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ADDRESS AT THE ANNUAL GENERAL MEETING
Admiral Sir William Goodenough 97

THE ANGLO-ITALIAN SOMALILAND BOUNDARY
Lieut.-Colonel J. H. Stafford 102

TALEH . . . . . W. A. Macfadyen 125

THE EFFECT OF WAVE INCIDENCE ON THE CONFIGURATION of a Shingle Beach. . . . . W. V. Lewis 129

ISLAND ARCS AND MOUNTAIN BUILDING . . Philip Lake 149

TECTONIC GEOLOGY OF THE MEDITERRANEAN: Review
Arthur Holmes 161

THE REGIONAL GEOGRAPHY OF SIEGFRIED PASSARGE: Review
J. F. Unstead 164

REVIEWS MONTHLY RECORD MEETINGS
SOCIETY'S NOTICES i COUNCIL LIST iii CONTENTS v

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The
GEOGRAPHICAL JOURNAL

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ADDRESS AT THE ANNUAL GENERAL MEETING
of the Society held on 22 June 1931, by the President

ADMIRAL SIR WILLIAM GOODENOUGH, G.C.B.

IN making my Presidential address I am somewhat encouraged by the remembrance that my great-grandfather and my grandfather each in his day made a similar effort. It is gratifying to note that the Society has progressed on the lines which were then indicated and that its main principles and aims have not varied. The Report of the Council for the year 1930 is with you and I will not elaborate that statement. From it you will see that the Fellowship of the Society continues to increase: I will mention the necessity of that increase later.

The outstanding event of the year in the history of our Society was the celebration of the Centenary and the opening of this Hall and the buildings adjoining it for the use of Fellows. A description of the celebrations will be found in the Centenary Number of the *Journal*, and also in a reprint which has been issued separately. The celebrations were, I hope, entirely satisfactory. They brought together a very large number of Fellows, representatives of kindred Societies, and Gold Medallists of past years. Men and women distinguished in all branches of science came from other countries for an exchange of ideas of which every advantage was taken, and the warmth of the letters which we have received is very encouraging. I would call attention to the fact that the distinction between Honorary and Honorary Corresponding Members has been abolished, and all are now included in one list of Honorary Membership.

In this Hall and the buildings surrounding it Fellows may see the fulfilment of the aspirations of one hundred years. This fulfilment may rightly be said to be shared by every Fellow who has belonged to the Society since its beginnings. Each by his fellowship may with justice feel that this house is his own. There are those to whom a special tribute is due: to Lord Curzon, who perhaps first realized the necessity for moving and then put his idea into execution; to Dr. Hogarth, who cared so greatly for and put forward with such force and charm the benefits which would accrue to the Society from having the Library in a proper setting; and to my predecessor, Sir Charles Close, who was the President during the years when the final arrangements had to be made,

Few realize the extent of the work which fell to him in the last three years, his application and his unerring judgment, his care that all should be given an opportunity of expressing their opinions, and his summing up of the whole. These are things for which we owe him a deep debt of gratitude.

Each day spent in this building, and every meeting, gives it more and more a feeling of completion and fellowship, and it is hoped that the amenities offered by these extensions, particularly in the Library and the Map Room, may encourage others to join the Society. A description of all that led to the fulfilment of these aspirations is admirably given in Dr. Mill's most informative and entertaining book, 'The Record of the Royal Geographical Society,' and I am glad of this opportunity of paying a public tribute to Dr. Mill for the devotion with which he undertook this work and for the many years of constructive attention and affection which he has given to the Society. I would venture to repeat what I have said at our evening meetings: that the new Map Room is intended to be a room for work and not just for the display of some of the treasures which hang on its walls. Most important has been the opening of the new Library, and here I welcome the opportunity of thanking Mr. Heawood and his staff for the admirable way in which all the books were moved from the old Library to the new. It was done with great rapidity in order that Fellows should be as little inconvenienced as possible and entailed much hard work cheerfully undertaken by the Library Staff. The whole of the 70,000 volumes had to be re-pressmarked, and this is being done. When completed it will give easy reference to our unique collection of books of geographical science in all its branches. Among the additions to the Library and Map Room (for I can quite imagine that the Librarian and the Map Curator might be at enmity as to which could lay claim to them) are the very beautiful collection of atlases of Ptolemy, Mercator, and Braun and Hogenberg given to us by Mrs. Yates-Thompson in memory of her husband, and the two atlases, one of Saxton and one of Ortelius, given by Miss Ursula Cust in memory of Sir Charles Cust, a Fellow of many years' standing. Sir Matthew Nathan's gift of books on Africa and China has gone far to complete our collection of the literature of these countries. Other additions of importance will be found mentioned in the Report.

You will, I am sure, read the remarks about this Hall in the Report with interest. Since it was written some criticisms have been made on the acoustics, but I believe that any difficulty of hearing which has occurred from time to time may have been due to the fact that some lecturers are more accustomed to the field of adventure than to the platform. With a gentle warning to the speaker that it is the audience, not the pictures on the screen, that desire to hear the lecture, I have no doubt that this difficulty will be overcome. We are pleased to be able to display some of our treasures to better advantage; that part of the western wall on which a record of recent events is posted will, I hope, add to the general interest.

Scientific instruction at the hand of Mr. Reeves is one of the matters which I regard as of great importance. In this connection a Sub-Committee has been appointed by myself to inquire in what direction and on what principle we can assist in the study of aerial navigation and survey; for that activity is becoming of more and more importance each year, and it is possible that in the rapid

advance of aerial communication research may have fallen somewhat into arrear. For many hundreds of years this country has been pre-eminent both in sea navigation and land and sea survey, and it is essential that such methodical research should be carried out in these new methods as shall ensure that we are not behindhand. The aerial compass requires much study.

I think that the afternoon lectures deserve the publicity that would ensure a larger attendance for them. There are probably many Fellows who are discouraged by the rather abstruse sound of some of the titles. I wondered myself for some time what useful contribution I could possibly make to such a lecture as that of Dr. Vening Meinesz on "Gravity Anomalies in the East Indian Archipelago"; but when I saw his diagrams and listened to his clearly expressed theories and lucid explanations, I realized that a fresh and absorbing interest was being awakened in me, and I hope that many others may have felt the same.

You have heard a short account of those journeys and that work for which Medals and Awards have been granted. Other expeditions also are receiving close attention, notably of course that of Mr. Watkins in Greenland. Labrador and its coastal islands, Tanganyika Territory, Lake Rudolf, and other places are being studied by those whom we have assisted and are assisting. I would call your attention particularly to the large number of instruments which we are able to lend to various expeditions.

The Society has to deplore the loss of many well-known Fellows: among them Marshal Joffre, who honoured us by accepting Honorary Membership during the darkest days of the war; Captain Otto Sverdrup, a distinguished Honorary Member, whose name has been long and honourably associated with that of Nansen; and Admiral E. de Vasconcellos, for a long time the permanent and moving spirit of the Portuguese Society in Lisbon. In Mr. A. P. Maudslay, who had served so long as Honorary Secretary and Vice-President, the Members of the Council lost a great friend. With characteristic generosity he had given us during his lifetime a large collection of his geographical negatives, and he bequeathed to the Society not only further pictures and instruments, but the sum of £500. The murder in Burma of Lieut.-Colonel Henry Morshead has caused a great loss to the Survey of India and to our Society. He was a gallant member of two Mount Everest Expeditions, and was greatly disappointed when he was forbidden to go on the third because of the frost-bite which he incurred on the second. Another Member of Council whose loss we have to deplore was Air Vice-Marshal Vesey Holt, who was killed by an accident while flying on duty only a few days after he had taken up a high appointment to command the air forces of the Fighting Area. The list is long. I must mention also Vice-Admiral Sir Charles Royds, one of Scott's officers in his first expedition to the Antarctic, Dr. J. W. Evans, and Mr. F. D. Harford, former Members of Council; and Mr. A. E. Young, who had contributed so much to our scientific publications in his treatise on Map Projections. Of distinguished travellers we regret Mr. St. G. Littledale, who died at a great age, and Dr. Emil Trinkler, who died all too young. We have to deplore at this Annual Meeting the loss of these and many other Fellows of the Society. Finally, a terrible flying accident took from us only last week a lady Fellow, Mrs. Enid Gordon-Gallien, who organized a party to survey the Kalambo

Falls, and would, had her life been spared, have done more excellent geographical work.

It is a matter of the greatest encouragement to find that whereas a hundred years ago there was not a single Professor of Geography there are now in the United Kingdom and the Irish Free State no fewer than ten. Cambridge recently raised the Readership to a Professorship, and Oxford have now followed suit. It is on this appreciation of the need of the future that I would make some remarks. It would appear that progress, far from simplifying life, makes it more complicated. It is an age of treaties, pacts, and conventions. Montaigne once said: "*Tout savoir c'est tout comprendre, tout comprendre c'est tout pardonner*." Knowledge is not enough. If we possessed knowledge only we should be filled only with astonishment that others did not behave exactly as we do. If the next generation is to enter into the complications of succeeding years with proper judgment they must have that comprehension which will enable them to study with sympathy the different aspects of different peoples. Some half- or ill-informed persons think that uniformity and standardization are what we should aim at. Far from it: what we aim at is the comprehending tolerance of others. A comprehension of problems and the peculiar difficulties of each will get past that sense of curiosity with which men look through the bars separating them from something that they do not understand; and it may be claimed without exaggeration that the science or art, call it what you will, of geography taken in all its breadth is a basis for the extension of such knowledge and comprehension of the problems of others. Never was there a wiser remark than that of the Shaikh Salih to Mr. Bertram Thomas: "Each country has its own Prophet." That, said by one belonging to what is supposed to be a sect of great Puritanism, is a lesson which all may learn; and I trust that the appreciation of the importance of geographical science in our schools of learning will be marked by a comprehension of international problems which will be of great benefit to the world. The Society has ever encouraged such an advance, and I can imagine that the heart of Mr. Douglas Freshfield will be stirred with pleasure, for his efforts in this direction have been great, and the memory of Sir John Keltie is also with us in the admirable way that he put forward the claims of geography.

There is another matter which I will touch on briefly to which geographical science must devote its attention more and more; that is, the placing of population which becomes surplus in the countries of its origin. Lectures have been given in this Hall and papers have been written in our *Journal* on all those ramifications, if I may call them so, of geography—human, regional, land utilization, and the like. I find myself in complete disagreement with a man who spoke not long ago on the future of the human race. If he were serious his remarks were harmful to the country. I am not aware of what steps he proposes to take to reduce the population of this island to 20,000,000. At the time that he mentions it is far more likely that the descendants of the present population will have risen to a far higher figure, and it is for them that places must be found on the Earth to live in happiness and security. That such places do exist is certain, for if it were not so the inhabitants of this world would seem to be condemned to a future of misery. We in this Society will do our best to assist in every way those who wish to put forward their ideas on such subjects.

The work of the Society during the last year has been strenuous and could not have been successfully accomplished but for the ardour of Mr. Hinks, our Secretary, and the Staff who work under his direction. I have referred to the three departments, the Secretariat, that of the Library, and that of the Map Curator, and it is with a deep sense of gratitude that I speak both on behalf of myself and every Fellow at home and abroad of the loyalty and ungrudging labour that they have given.

In conclusion may I say that I believe the progress of this Society is laid on sound foundations, and I confidently leave myself and the Royal Geographical Society in the hands of its 6600 Fellows with the hope that that number will before long be largely increased.

THE ANGLO-ITALIAN SOMALILAND BOUNDARY: *A paper read at the Evening Meeting of the Society on 1 June 1931, by*

LIEUT.-COLONEL J. H. STAFFORD, R.E.,
Senior British Commissioner

I SHALL deal with the actual demarcation of the boundary between British and Italian Somaliland; but before I start on this I would say a few words on the country itself. Somaliland lies to the south of the Gulf of Aden, in what is often known as the Horn of Africa. British Somaliland is bounded on the east by Italian Somaliland and on the south and west by Abyssinia and French Somaliland. It is with the eastern boundary that I shall deal. The Somalis are said to be descended from inhabitants of Arabia who absorbed or drove out the previous Galla inhabitants. They are divided into several sections. The Darod, which consists of the Warsangeli, the Dolbahanta, and the Mijertein, inhabit this eastern side of Somaliland.

From 1860 to 1884 the coast of Somaliland was in possession of the Khedive of Egypt. It was then evacuated and Berbera was taken over by the Aden garrison. In 1887 Protectorates were declared by England, France, and Italy over this part of Africa. In 1895 Muhammad 'Abdullah, known later as the Mad Mullah, began to obtain influence in the east amongst the Dolbahanta. Operations against the Mullah were carried out from 1901 to 1904 without much success. In 1910 the interior was evacuated by us and only the ports were garrisoned. The Mullah's influence spread westward to Burao. From 1913 the gradual reoccupation of the interior was commenced, and final operations in 1920 led to the dispersal of the Mullah's followers. The Mullah himself died in Ogaden country in 1920.

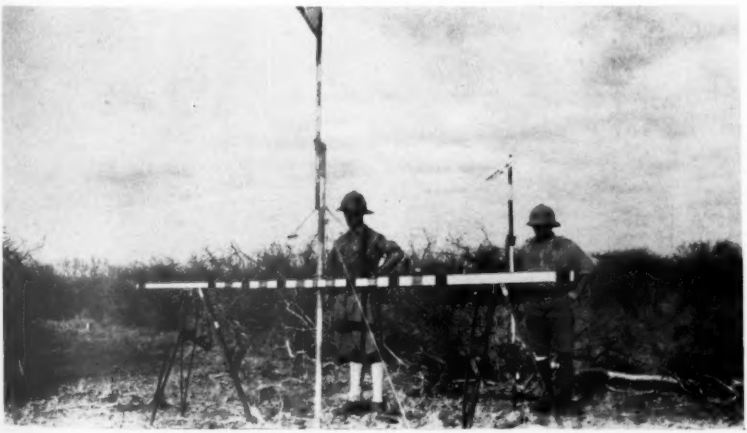
Somaliland in the region of the 49th meridian consists of a low plain stretching inland from the coast for a depth of 15 miles. Out of this plain rises steeply a line of hills reaching a height of 1800 metres. The general level then falls away gently southward, terminating, as far as we were concerned, in the Haud, where the height is approximately 600 metres.

Taking this in more detail, there is first the coastal plain from the sea to the Maritime Hills. Near the frontier this plain is only from 1 to 2 miles wide; water is scarce, and there is no grazing. Then the Inland Plain is reached: again a flat plain about 10 to 15 miles wide. After rain there is fair grazing for a short time and water can be found in many wells and water-holes. The general vegetation is scattered thorn scrub and the height is about 150 metres above sea-level.

The hills, known as the Al Hills on the British side and El Maskad on the Italian side, rise steeply out of the Inland Plain. The ascent is by a series of steep pitches with intermediate ledges. The summit is about 1800 metres. There is a gap through the barrier of hills known as the Dagan or Karin Pass. This lies in Italian territory. The Italians have made a road down this pass leading to Banda Kasim and there is a well-defined camel-caravan track leading from the interior to the coast. Some 10 miles west of the boundary the main mass of hills is broken up into several ridges divided by deep ravines. To traverse this from north to south is very difficult, and a distance of about 4 miles on the map may mean a journey of some nine hours. On the south side

Motor road up the Sheikh Pass

Water hole at Bukh Shanle near Las Anod



Subtense bar at Darken Ghenyo, 47° E./8° N.

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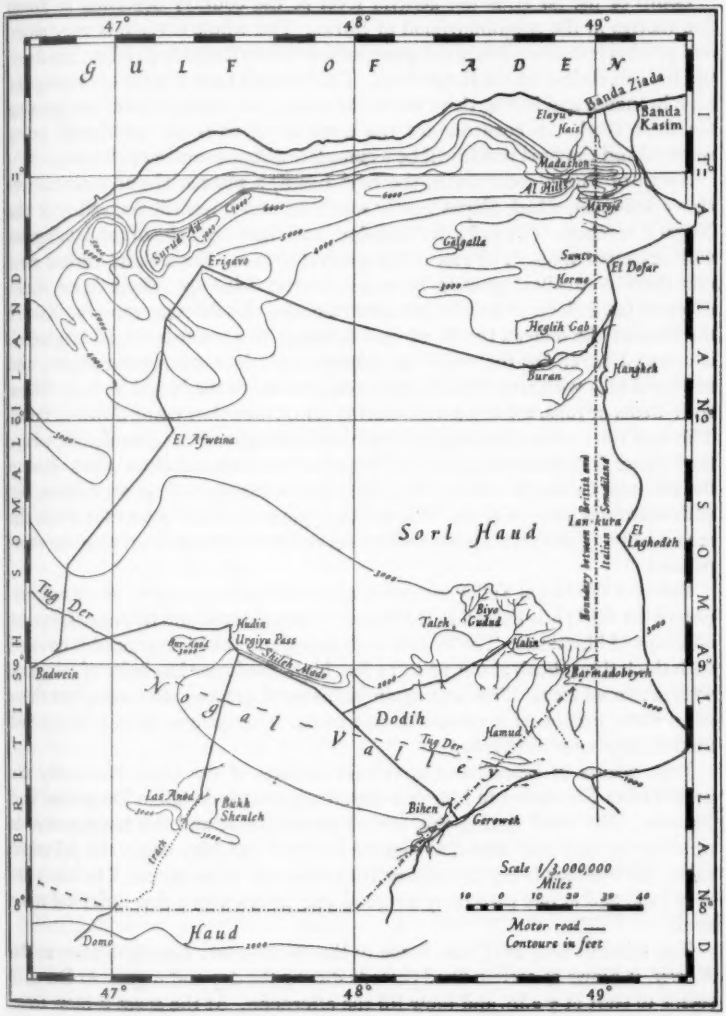
Italian motor road at Tishe

Looking east along boundary line from the final point, Darken Ghenyo

of the range the hills descend less steeply but are broken up by innumerable watercourses with steep sides.



Sketch-map of British–Italian Somaliland Boundary

At the Surud Ad, which is north-west of Erigavo, there is a sheer drop of 2000 feet on the north side. Within the area of the range there are a good number of wells and water-holes, with good vegetation round them. Gum trees are found on the slopes of the hills. The Somali does not cultivate these

trees, but certain areas belong to certain families, and the mature trees are tapped for the gum, which is exported in fairly large quantities.

South of the Al Hills the general level of the country descends to about 800 metres in the neighbourhood of Buran. The whole surface is very stony and grazing is scarce. When the grass, which is only found in patches, has dried up, the camels live on the thorn trees. The Somalis have a habit of cutting the high branches and letting them fall to the ground to provide additional grazing for their stock. In consequence the number of trees is continually being reduced and the final result will be a complete disappearance of all trees.

South of Buran commences the Sorl Haud, a plateau about 1000 metres above sea-level, which slopes gently south for 100 miles till the valley of the Nogal is reached. The soil is red in colour and there are belts of thick tall grass with scattered trees. The rest of the ground is bare. For a short period after rain there is excellent grazing here, but it soon dries up. There is no water except what collects in *ballehs* just after rain, and this dries up rapidly. East of the frontier the plateau breaks up and descends to a lower level; El Laghodeh is situated here. On the south the plateau ends in a steep escarpment, and scattered hills with river-beds in between, leading to the Nogal Valley. These river-beds, or tugs, are dry except during rain, when they come down in flood. The tugs run out into the plain of the Nogal and spread out into deltas, where they cease. The general level of the Nogal is 500 metres, and its width close to the Boundary about 80 miles. It is a flat, featureless plain, in general open, but with scattered belts of trees. The soil is gypsum and any water found in the area is salty. After rain a grass springs up and provides good grazing for short periods.

South of the Nogal Valley is another plateau which appears to be a continuation of the Sorl; it is known as the Haud. The soil is red and there are frequent outcrops of limestone. The level is undulating and the high ground is covered with thick thorn bush about 10 to 15 feet high, the lower has belts of tall grass with scattered trees. This area again yields good grazing after rain, but there is no water except what occurs in rain pools. The general level is about 600 metres, sloping southwards.

Rain occurs in Somaliland at certain seasons of the year. Generally the period from November to March is dry, though rains do fall in December and January. The wind during this period is north-east and the temperature is mild by day and cold inland at nights. In April and May occur the principal rains, the weather being hot and sultry before the rains occur. The rains are very local and at one place may be good and at another a few miles off none at all.

The wind in May and June turns to the south-west. Locally known as the *Kharif*, it blows at certain fixed periods during the day and night. At Burao it seems to start at 7 a.m. and blow till the afternoon. At the coast it blew from about midnight to midday. Inland at Las Anod it blew the whole time, but hardest from about 9 a.m. to sunset. It raises whatever dust there is, and Burao during this period lives in a dust cloud. Its strength was so strong at Las Anod that the two aeroplanes that came there in July could only just be kept on the ground weighted with all the stones we could tie on. It is hard work to walk against the wind and quite impossible to keep an instrument up or read it.

Fortunately in the Haud the strength of the wind was broken by the trees. The temperature at Berbera from May to October is very high, but up country not too bad. In October occurs the change again to the north-east wind.

There are no flowing streams in Somaliland. Water is found in wells and in pools in the river-beds. Generally the water is bad in quality and insufficient in quantity. In the north there is a lot of sulphur in the water, and in the south salts. The best water we found was at Buran spring. For a person moving from one source of water to another there is sufficient, but for the purposes of the Commission where we had to go in a certain direction and only move as required for the work, the supply of water was difficult. Crossing the Sorl, the Survey party had to send back for drinking water to Buran; and in the Haud they had to get all their water from the neighbourhood of Las Anod. When in the Nogal at Halin, we used to send 100 miles to Buran to fetch drinking water. Water was transported in 12½-gallon iron tanks, two full tanks being a camel load. We were told that they would not stand up to the battering as well as tanks made of copper, but we found them perfectly satisfactory.

The Somalis are a nomad race. There are villages on the coast at the ports, but none up country except where the Administration has settled down, such as Sheikh, Burao, and Erigavo. The Somalis move with their camels, sheep, and goats to whatever spot will give the best grazing. Usually they live on camel milk, but when they can get it they eat rice, dates, and ghi. They are quite content with their flocks and generally do not wish to undertake any manual labour. The men of certain tribes do emigrate, and are found in most parts of the world, but they all eventually find their way back to Somaliland and return to their karias and live the simple life again. Their main relaxation seems to be raiding the flocks of other tribes. The men all carry a spear or rifle, and in general look after the camels while the women look after the sheep and goats. Only the male camels are used for burden.

We collected the coolies we wanted through the District Commissioner. Before they understood what was required of them they were not much use, but after a few weeks they settled down and worked very well. We gave them no special clothing but a ration of 1 lb. rice, ½ lb. dates, and 2 ozs. ghi.

The Somali is not very good at cutting timber. The local tool is a gudimo, which might be described as a miniature axe-head on a long handle. It is all right for cutting small branches, but no good for large trees. We found that they were unable to use European cutting tools, but succeeded rather inefficiently with a cross-cut saw.

The Somali has no written language, and so his memory is good. He knows to the anna what pay is due to him. He likes to have his grumble, but given a fair hearing he will accept the verdict cheerfully. Throughout the time we were there we had no trouble with our natives. There was the occasional broken head, but nothing in the nature of a strike. They are on the whole a clean race and make good personal servants.

The Somali burden camels take a load of about 160 lb. each side. The loads are tied on to the saddle with rope made from a local plant. The saddle is known as a Heriot and consists of several grass mats laid on the camel's back. The whole thing appears to be most unsafe, but the loads usually remain in

position. It is the exception for a box to be tied on right side up, so all boxes have to be packed carefully. The camel transport required had all to be hired. The arrangements for this were made for us by the District Commissioner. When the whole Commission was on the move we required about three hundred camels. The bulk of these were not retained, but were discharged on the completion of the move. The Survey party, which was moving almost daily, had to keep all theirs; but Headquarters, which had the bulk of the stores, was not required to move so often.

The Somaliland Government have a few Morris trucks, almost entirely Chevrolets. Motor tracks have been made which are quite passable in dry weather, but are impassable in wet. The track is made by clearing away any vegetation and filling up holes. A main track runs from Berbera to Burao, reaching the plateau up the Sheikh Pass. This is a very well-graded road and was constructed, I believe, by Indian Pioneers at the time of one of the operations against the Mullah. It has been greatly improved, but is still frequently blocked in wet weather by falls of rock.

From Burao a track runs down the Ain Valley to Badwein, where there is a fork. One branch turns north and, crossing the Der Valley, goes to Erigavo and thence on to Buran. The other carries on to Hudin and then turns through the Urgiyu Pass and down the Nogal Valley, where it splits, one branch going to Halin and the other to Bihen.

We had with us two Morris six-wheeler trucks, which were invaluable. We could get very nearly anywhere with them except in the really hilly districts. The Somali is not a good motor driver; he cannot understand the use of gears or how to change down. We did not like to risk our six-wheelers, and so these were always driven by a member of the Commission. We had with us a sergeant R.A.S.C., who kept them throughout in excellent order. At the end of the time each truck had developed a crack in the chassis at the same place which indicates a weak point there. The tracks supplied with the trucks are useful, but can only be put on by reversing on to them, so you must put them on before you get bogged. Crossing the Nogal in May 1930 we struck a very wet patch after rain, and despite our tracks we got badly stuck. After some time one truck was persuaded to cross the worst patch backwards and then pulled the other one through. On another occasion one truck was crossing a tug in flood and suddenly dropped into a hole and the whole engine went under water. It was towed out backwards, but several days had to be spent in taking the engine to pieces and clearing the mud and water out of it.

The Government have wireless stations at Berbera, Burao, and Erigavo. Communications east of Burao and Erigavo are by runners who travel about 25 miles a day. We had our own runners who took the mail in weekly to the nearest centre. Mail from England took the same time to get to us from Burao as it took to reach Burao from England.

Turn now to the actual work of the Commission. The Anglo-Italian Protocol of 1894 defined the Boundary in these words :

> "The Boundary of the spheres of influence of Great Britain and of Italy in the regions of the Gulf of Aden shall be constituted by a line which starting from Gildessa and running towards the 8th degree of north latitude skirts the north-east frontier of the territories of the Girrhi, Bertiri and Rer Ali tribes....

Phot. C. Barrington Brown

Somali native types

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Phot. R.A.F.

Road through country south of the Al Hills

On reaching the 8th degree of north latitude the line follows that parallel as far as its intersection with the 48th degree of longitude east of Greenwich. It then runs to the intersection of the 9th degree of north latitude with the 49th degree of longitude east of Greenwich and follows that meridian of longitude to the sea."

In a subsequent agreement between the two Governments it was settled that although the village of Banda Ziada had been found to be west of the 49th meridian, it should remain in Italian territory.

It was not till 1929 that it was finally agreed between the two Governments to carry out the demarcation of this frontier. Previous to this, at the urgent request of the British Somaliland Government, a party was sent out to do a preliminary survey and ascertain, for British information only, where the frontier lay. Accordingly, Major Phipps, R.E., and Mr. Taylor, R.A., were sent out from England and landed at Berbera on 31 December 1928. It so happened that H.E. the Governor was giving a fancy dress dance at Government House, Berbera, that night, and these two officers were taken off the boat, assisted into their dress clothes, and taken to it. As most of the Administration of Somaliland were present, it was an excellent opportunity to meet every one, and I gather they spent a very enjoyable evening.

Major Phipps's party, which became known as the Eastern Boundary Survey, went up to Erigavo by truck and then trekked from there to Buran. They were accompanied by an escort from the Somaliland Camel Corps.

Buran was known to be somewhere near the frontier and was selected as the starting-point. Having fixed Buran, they carried a triangulation northward to the coast, which was reached on 6 April 1929. By this time the Commission had been agreed on, and Major Phipps, realizing that he would not have time to continue his triangulation, decided to run a traverse south from Buran, checking it by astronomical observations at important places. By July 1929 he had reached the Nogal Valley, having worked past El Laghodeh to the corner at 49°/9° and thence to Bihen. Meanwhile on the other side of the frontier the Italian Government also had a party of surveyors at work.

In May 1929 it had been settled that work should commence in September 1929. The British Section was to consist of myself as Senior Commissioner; Major Phipps and Mr. Taylor (already in Somaliland) as Assistant Commissioners; Major Horsley, D.S.O. (who is a D.C. in Somaliland), as Political Officer; Major Twigg, R.A.M.C., Medical Officer; Mr. Barrington Brown, Geologist; three military surveyors, one motor mechanic, and one wireless operator. Hearing that this Commission was to proceed to Somaliland, the Director of Kew arranged to send a Botanist, and Mr. C. L. Collenette was selected.

Up to the time of departure from England the personnel of the Italian Section was not known, but when finally we met they were found to be: Cavaliere (later Commendatore) Cerulli, Senior Commissioner; Cavaliere Mosconi, Assistant Commissioner; Capitano Cabitto and Tenente Borra, Surveyors; and Dr. Failla, Medical Officer.

It had been proposed by the British Government that the actual mapping of the frontier should be done from the air, to which the Italian Government agreed. The Air Ministry had consented to supply the machines and personnel.

The details of the work were left to be settled on the spot, but the actual plotting from the air photos was to be done by the Geographical Section at the War Office. There was already a detachment of R.A.F., with two machines, stationed at Burao. Aerodromes had been cleared and existed at Erigavo, Buran, Halin, Bihen, and Las Anod. The Italians were known to have aerodromes at Banda Kasim, El Laghodeh, and Geroweh.

I began work in London in the middle of June. As time was short, stores had to be despatched direct to Berbera without inspection. The Colonial Office were anxious that I should go out to Somaliland as early as possible to get in touch with the Italians. Actually I left England in the middle of July and was followed on August 1 by the remainder of the Commission. I was able to meet at Aden the officers of the R.A.F., who were to assist us, and Flight-Lieut. Shaw crossed to Somaliland with me. On arrival in Somaliland Flight-Lieut. Shaw and I proceeded by truck to Hudin, where we met Major Phipps, who had trekked back from Bihen, to discuss the future work in the light of the experience gained during his preliminary survey.

Buran seemed the most suitable place to concentrate the Commission, as it had good water and the temperature would not be too high. It was thought that if work commenced about September 15 that we should be ready for the Air Survey Flight to start photography about December 1. We finally arranged for Major Phipps to come back with us to Burao, and instructions were sent to Mr. Taylor to take the personnel of the Boundary Survey and be at Buran by September 1. On return to Burao a conference was held by the A/Governor, and an escort and escort officer from the S.C.C. were arranged for. Flight-Lieut. Shaw then returned to Aden by air, and we went on to Sheikh and so to Berbera by August 11. The rest of the Commission arrived at Berbera on August 12.

Berbera harbour is very silted up and all stores have to be unloaded into lighters, which even then can only get alongside the piers at high water. At this season (August) the Kharif wind is still blowing, and at Berbera starts during the night and blows till midday; so as high water was then in the morning, the stores had to remain in the lighters till the 14th, when there was just enough water to get the lighters alongside in the evening. All the stores had been packed in bulk in England, and these had now all to be unpacked and repacked in suitable loads for camels. Meanwhile we were still in ignorance of the whereabouts of the Italian Section, so our plans were communicated to the Governor of Italian Somaliland.

We were hampered by the non-arrival at Berbera of many stores, and ultimately Major Phipps and one N.C.O. were left at Berbera to collect the two Morris six-wheeler trucks when they arrived and bring them up to Buran. The remainder left Berbera on August 29 and, travelling up by trucks *via* Burao, reached Erigavo on August 31. Here we found our first batch of camel-loads which had only just arrived, and no camels to take them on. However, we off-loaded the trucks and reloaded with essentials, and next day I went on to Buran, where already the Political Officer, Escort Officer, Mr. Taylor, and his party had arrived. At Erigavo we got a wire to say that the Senior Italian Commissioner was in Abysinnia and was due to leave there on August 23. The rest of the Commission arrived at Buran on September 4. Throughout the rest of

September camel loads arrived, and by the end of the month the Commission was complete except for Major Phipps and the six-wheelers.

On September 30 contact with the Italian Section was obtained, when it was arranged for Cavaliere Cerulli to come to Buran on October 2. Major Phipps also arrived on this day and was able to be present at the conference that took place on the future working. It was arranged for the survey parties to meet on October 7 on the frontier at Heglih Gab, which is east of Buran: they were to fix a point on the boundary and then carry the line northwards to the coast. Meanwhile the Senior Commissioners as a Political Section assembled at Banda Ziada and subsequently during November and December at El Laghodeh, Hudin, and finally at Buran. Evidence was taken from the natives about their country and grazing areas. After this Major Horsley left us to begin work on the Claims Commission, which was being formed as part of the Boundary Commission.

The survey parties assembled at Heglih Gab on October 7. Using the triangulation carried out by the Boundary survey, Major Phipps fixed a point on the 49th meridian. The Italian surveyors took astronomical observations and also fixed a point. The mean of these two positions was taken as the 49th meridian, and observations for azimuth carried out to obtain the direction of the meridian. Work on the actual demarcation commenced on October 21. It had been laid down that the boundary was to be marked by a series of pillars which were to be intervisible. It was decided not to build these of masonry but to put a concrete mark in the ground and erect a cairn of stones over this to a height of about 6 or 7 feet. These cairns were roughly 1 kilometre apart, and in places where the vegetation was thick enough to warrant it, a lane 6 metres wide was cleared of trees and bushes as well.

In this part of the boundary from Heglih Gab northwards it was arranged for the two survey parties to work together. The Italian surveyors were to mark the line of the boundary with temporary cairns at suitable intervals, while the British surveyors, using the previous triangulation, should fix points about 8 kilometres apart along the boundary. These were to act as control points for the air photography and also served as a check on the line. The coast was reached at the end of November and further astronomical observations taken. The effects of local attraction on the values obtained are dealt with in an appendix to this paper.

The actual limits of the Banda Ziada Enclave had not been settled, so the demarcation could not be completed at the coast. The survey parties started working back along the line on December 16, replacing the temporary marks by numbered concrete marks and erecting cairns. The next section from Heglih Gab to the corner at 49°/9° was across the Sorl Plateau and was waterless except after rains. Both missions had already made astronomical observations at 49°/9° during the preliminary survey, and it was decided that as triangulation on this flat area was not justified, the work should be divided. The British were to start at Heglih Gab and work south, and the Italians were to take the mean value at 49°/9° and work north. It was hoped to meet in the latitude of El Laghodeh, where both sides had subsidiary astronomical points though not at the same place. The British party were able to complete the work, as they progressed, of numbering and erecting the cairns, but the Italians had to leave

theirs to be completed later, so as to keep the numbers consecutive. Control points were made as before, about 8 kilometres apart.

For the first 24 kilometres south of Heglih Gab the country is hilly, and progress was good as there was little cutting to do. The weather was cloudy and observations could be continued till about 11 a.m. The line then reached the Sorl Plateau. Here observations, owing to mirage, were impossible after 7.30 a.m., and could not be resumed till after 5 p.m. The wood of the thorn trees is very hard and axes made little impression. After reaching the Sorl, one six-wheeler truck remained with the survey party to collect stones for building the cairns, as there were frequent patches where no stones were to be found close to the line.

The British party met the Italians on the 18th, and then moved to Halin to refit on February 28. It had been hoped that the Headquarters camp could keep in close proximity to the survey parties, but owing to the lack of water and the difficulty of keeping sufficient camels in an area of little grazing, this was found to be impossible. A move was made to Hormo; but when the surveyors had reached the Al Hills going north, the camp moved back to Buran, where there was good grazing and where the R.A.F. were due to establish their camp.

On January 20 Mr. Collenette, the Botanist, had suddenly gone down with blackwater fever. Thanks to careful nursing by Major Twigg, our Medical Officer, he recovered and was sent by air to Berbera on February 10.

Headquarters remained at Buran till February 12, when a move was made to Halin, the camels going straight across the Sorl and the trucks round by Erigavo and Hudin. The parties reached Halin within a few hours of each other. The trucks could have gone across the Sorl except for the descent on the southern edge, and with a little work this would be quite feasible.

The survey parties arranged to meet at Bihen to fix a point on the boundary there. The mean of the British and Italian values was accepted and a point marked on the ground. The arrangements were for the British to do from 49°/9° to Bihen and the Italians from Bihen to 48°/8°. Both parties to meet again at 48°/8°, which had not yet been fixed astronomically by the British Section. The British party left Halin on March 17 for 49°/9°, and on arrival started to work south-west towards Bihen. The first part was over hilly ground descending from the level of the Sorl Plateau. Then the plain of the Nogal was reached. As there was no stone in parts of this area a party was sent out from Headquarters with the two trucks to complete the cairns after the surveyors had passed. The British party joined the Italian work at Bihen on April 17 and then moved on (along the Italian work) to 48°/8°, making a sketch-map as they went. Unfortunately, air photography does not do everything for the surveyor. It cannot photograph the names of places, so a ground survey is still required to supplement the air photographs.

The Italian party had struck a difficult patch of country in their section. This was thick thorn-bush and very difficult to penetrate. To add to their troubles one survey officer was sick, and this left the other officer alone. The Italians reached 48°/8° on May 2, and the corner was fixed by May 8. Headquarters moved from Halin to Las Anod at the beginning of May. Las Anod

was quite green when we arrived, but by June this had all dried up and returned to the normal dry, dusty appearance of Somaliland.

The survey parties now entered on the most difficult section of the line, The country near the line consisted of thick thorn-scrub about 10 feet high, The branches were much interlaced and the only tracks go north and south, so they had to cut their way along. Major Phipps left the Italians at 48°/8° to start working west and moved to a point which he hoped would bring him halfway to 47°/8°. Actually the first point he took was considerably nearer 48°/8°, but as the second Italian officer had not yet returned, this was all to the good. A lane 6 metres wide was cut through the bush and pillars erected at the usual interval. It is hoped that the lane will last many years, as growth of bushes and trees is very slow. Arrangements can easily be made to keep it clear. This lane shows up very clearly on the air photos. The British arrived in the vicinity of 47°/8° on July 6. The Italians arrived on July 11, but the final point 47°/8° was not settled till July 20.

The Air Survey Flight reached Buran at the beginning of December. Flight-Lieut. Shaw went to Banda Kasim and met the Italian Air Survey officers. It was then decided that each section should carry out the photography independently as, owing to the cameras being different and various other causes, it was not possible to divide the work. As the boundary was undefined on the ground it was not possible for the flight to take photographs and for the surveyors to fix subsequently points which could be identified on the ground. The flight had to rely on marks made on the ground to guide them in taking the photographs.

It was arranged to make these marks 4 or 5 miles apart, and to fix them so that they would act as control points for the subsequent plotting of the map. The width of ground to be photographed was about 5 miles, and this could be covered by three strips of photographs taken from a height of 12,000 to 15,000 feet. These marks were made in the shape of straight-sided letters and signs such as L, Y, ←, +, the actual point being the junction of the arms. The arms were normally 100 feet long for marks with two arms and 75 feet for three- or four-armed marks. To start with, the width of each arm was 6 feet, but this was later increased to 12 feet, which greatly improved their visibility. In the northern area, where stones were more common than bushes, and water was available, the marks were made of stones laid in the design and whitewashed. On the Sorl Haud and southward a clearing was made and the outline of the mark was constructed of bushes. If water was available the inside of the zariba was whitewashed. In two cases near the coast the mark was made by cutting a trench of the required shape in firm sand. In one case this showed up well, but in the other was barely visible, and this type was not used again.

These marks were accurately fixed along the boundary by ground survey (subtense traverse controlled by triangulation and astronomical observations). The heights of the marks and intermediate pillars of the traverse were found by theodolite and, in addition, the height of any other points which were likely to be recognizable in the photographs, were taken whenever possible. The height control thus provided proved to be the very minimum that was necessary and should be increased. The flight commenced work near the end of December. They had difficulty in taking the part over the Al Hills,

which was frequently covered in cloud. Having finished down to 49°/9° by February the flight moved to Halin and took the section from 49°/9° to 48°/8°, completing by May 10, which was the date the surveyors finished there.

The flight then returned to Aden, and it was arranged for Flight-Lieut. Shaw to return again with two machines to complete the last section from 48°/8° to 47°/8° as soon as this was ready. He came over in July, but there was a considerable amount of cloud over the Haud when he arrived, and the Kharif was so strong that it was not safe to leave the planes out in the open. He therefore returned to Aden and came back at the end of October, after we had left the boundary. The photographs were developed in Somaliland, and copies of them sent home to England. The actual plotting of the map from the air photographs is being done at the War Office by the Geographical Section, employing the Arundel method.

The equipment taken out by the Commission needs no particular comment. Major Phipps's party were equipped with English pattern green canvas double-fly tents, which did not stand up to the Kharif wind and had to be replaced by the Indian pattern Swiss Cottage tents that I had obtained for the rest of the Commission.

Having completed the actual demarcation of the frontier Major Phipps spent a further two months in the Nogal surveying for the map to illustrate tribal grazing areas. The Medical Officer and some of the N.C.O.s left for England at the end of August 1930. The rest of the Commission was ready to return to England at the beginning of November, but actually we proceeded by boat on November 3 back to Banda Ziada to have a final talk with the Italian Commission about the Enclave, prepared if an agreement was reached to demarcate that part which had not been done. We did not arrive at a solution, and so proceeded direct from Banda Ziada to Aden, where we were lucky enough to catch the P. & O. mail steamer, which was already in Aden harbour when we arrived. We caused some excitement by boarding the P. & O. still dressed in our normal dress of bush shirts and shorts.

Our relations with the Italian Mission were throughout very friendly. It was a great pleasure to work with them and we always met with great hospitality at any of their stations along the frontier. It has also been a great pleasure to welcome them here in England to finish off the work. Finally I should like to thank every one in Somaliland for their assistance and kindness to us. We received every help throughout our time in the country, and anything that we wanted was supplied to us.

Note on the spelling of names by the Ed. G.J.

The names on the map and in the paper have been spelled according to the decisions of the P.C.G.N., made on the authority of the Somaliland Government. The authors protest that some of these names are inconsistent with the results of their own studies on the ground, and would like us to adopt their alternative spellings. This we have been unable to do, being bound to follow P.C.G.N. decisions except for grave cause. The proper course seems to be to follow the P.C.G.N. lists in map and paper, but to submit in this Appendix the author's proposals for the favourable consideration of the Somaliland Government.

P.C.G.N.	*Boundary Commission.*
Sorl Haud	Sol Haud*
El Laghodeh	El La-Ghodei
Geroweh	Garowe
Heglih Gab	Higle-Gab
El Maskad	Al Mascad
Surud Ad	Surad
Erigavo	Erigabo
Badwein	Ba'ad Wen
Urgiyu	Urgiya
Taleh	Tale
Hamud	Hamur
Dodih	Doddi
Bukh Shenleh	Bukh Shanle
Barmodobeyeh	Bar-madobe

APPENDIX I.—SURVEY

Triangulation was employed in three areas: (*a*) between Buran and the sea; (*b*) between Barmadobeyeh (near 9°/49°) and Hamud; and (*c*) between Taleh and Damer.

In area (*a*) there were two bases: (1) in the Buran Valley, measured on surface of the ground by steel tape; surface very good; length 1325 metres; difference between two measurements = 1/28,400. (2) On the coast east of Elayu, measured on firm smooth sand by steel tape; length 888 metres; difference between two measurements = 1/15,700.

The maximum triangular error was less than 20″, and the difference in length of side T20–T22 obtained from the two bases = 0·6 metre or 1/22,800. Marks were cement blocks or crosses cut on large stones.

In area (*b*) was one base near 9°/49°, and very rough single-handed triangulation, no permanent marks or beacons. The main object was to fix the corner at 9°/49° from the astronomical point at Barmadobeyeh.

In area (*c*) was one base near Biyo Gudud, measured on surface of the ground by steel tape; surface very good; length = 4472 feet; difference between two measurements = 1/31,719. Triangular error: maximum 14″, average 9″; permanent cement marks and stone cairn beacons.

At the beginning only one theodolite was available; the second did not arrive till March 19. The country was very broken up, which often necessitated long detours to reach the required hill which in turn was often very difficult to recognize as the same one which had been seen from a distance. Mirage and haze were extremely bad except at dawn and dusk. The visibility from about 6 a.m. to 9 a.m. and from 5 p.m. to 6 p.m. was usually excellent, but on several occasions there was a thick mist over the hill-tops in the morning and rain in the evening. Since we had to observe at dawn and dusk the bulk of the trekking to and from trig. stations had to be done in the dark, and this added considerably both to the time and fatigue of the treks, owing to the nature of the going, which was always over loose stones and rocks. Later on the Kharif wind made it almost impossible to observe, but was not such a handicap as it might have been, for the only calm time during the day coincided with the time one could see through the telescope. When we tried to plane-table after the mirage got too bad to observe, the wind was often so strong that the whole plane-table was blown away and compass bearings had to be taken lying down.

*Sawl Haud is probably the correct spelling, and may be officially adopted in the future.

No timber was available for beacons, and the Somalis are experts at removing anything in the nature of iron or cloth. Stealing lengths of the telephone wire and golf-club flags are quite popular sports, and even the metal tracks of the six-wheelers are coveted. Stone cairns had therefore to be made for beacons. They were not only very difficult to pick up, and extremely poor marks to aim at, but nearly every hill had at least one cairn on it already. An attempt was made to improve these beacons by whitewashing them, but this was not a success, as the sun shone on one side of them, and it was difficult to tell where the centre of the cairn really was.

The projection used was Lambert's Conical Orthomorphic, with origin at 10° N., 49° E., and calculated with Clarke's figure of 1880. The metric units were used.

Astronomical observations were made at about twenty places by the British party: Latitudes by the circum-meridian method (four settings on each star). The average P.E. obtained was $\pm 0{\cdot}26''$. Longitudes by altitude of E. and W. stars near the Prime Vertical (four settings to each star), the times recorded by a tape chronograph. The average time taken for the four settings on one star was about three minutes, and the average P.E. obtained was $0{\cdot}33''$. Azimuths by the Hour Angle of E. and W. stars near the Prime Vertical (two settings on R.O. and two on each star for each set). The average P.E. obtained was $\pm 0{\cdot}2''$.

Normally six pairs of stars were observed for each determination of latitude, longitude, or azimuth, but at important points such as the Tri-junction Point at 8°/47° as many as twelve pairs were observed. Greenwich time was obtained by the wireless time signals from Bordeaux and Rugby.

Local Attraction.—Six points were fixed astronomically between Buran and the sea, and the presence of considerable local attraction seems to be proved by the comparison between the astronomical values and the trig. values based on BP 15 Heglih Gab: mean of Italian and British values: 10° 21′ 06·10″ N., 49° 00′ 00″ E.

	Latitude	*Difference Trig.-Astro.*	*Longitude*	*Difference Trig.-Astro.*
A1. Buran . .	10° 13′ 05·6″	+4·57″	48° 45′ 51·18″	+2·19″
T2. Buran . .	10 13 50·0	+0·26	48 47 19·15	+0·27
A2. Hobad . .	10 23 38·0	+1·01	48 57 57·06	−1·22
A3. Maroje . .	10 54 20·5	+2·36	48 58 29·5	−9·35
A4. Elayu . .	11 14 26·0	−7·50	48 55 17·73	+2·60
British Station, Banda Ziada .	11 14 58·8	−6·43	48 59 45·19	+4·50
		+ = more N.		+ = more E.

A1 is not a very reliable point.

W/T Time Signals.—The Rhythmic Time Signals sent by Bordeaux and Rugby were used throughout, and the corrections issued by the B.I.H. were applied later as they were received. The delay which occurs before these corrections are received made it necessary to accept longitudes before the corrections were applied. As the accepted longitude was usually the mean of the British and Italian values the error due to correction was not of great importance, and, when the correction was finally applied to the British value, usually came closer to the accepted mean.

The method adopted for taking the time signals was that used by Major Phipps in West Africa. The main principle was that the observer did no counting, but merely booked the times of the long beats and coincidences. The number of

beat intervals between the first beat and two coincidences was computed in one's head by a very simple fool-proof formula. Similarly the number of beat intervals between the other two coincidences and this last beat was also computed. The value in seconds of any number of beat intervals was obtained from a simple home-made table. Consequently one had two values for the error of the chronometer, at the first beat and at the last. The mean of these two values was taken as the error at the middle of the signal. A full description of the method employed is given in the new edition of *Field Astronomy* published by the S.M.E., Chatham. It is extremely simple and quick to use and it has been found from experience that a novice has no difficulty in using it. It is very similar to the method employed by the R.G.S., but differs slightly in that the formula has been specially designed to avoid complications due to faulty estimation of the beginning of the signal, and variation in the position of the minute in which there is no coincidence.

Since no counting of seconds or beats is done, the observer has very little to do while taking the signal and can concentrate on the times of the coincidences. Here, again, is another advantage, for when counting one must decide instantaneously on the coincidence in order to change over from counting beats to seconds. This is far from easy, as the coincidence appears to last over five or six seconds. In the method employed in Somaliland one can book the beginning and end of the coincidence and take the mean at leisure afterwards. Moreover this helps to prevent one anticipating when the coincidence will occur, for one does not realize at the time which the actual second was at the last coincidence.

As regards the actual recording of the signal an attempt was made to reproduce the beats on the chronograph. This method has been used elsewhere, I believe, but proved most unsatisfactory in Somaliland. It is, of course, the obvious way of recording a signal at an observatory, but in the field unless accumulators are carried to work a power valve one cannot make the W/T receiver record the beats on the chronograph through a relay. Any attempt to reproduce the beats by a telegraph key were defeated by the currents in the key circuit interfering with the W/T set, so that although one might appear to be pressing the key in perfect time with the beats it was really the W/T set repeating one's own key beats. The comparison of the coincidences was therefore made by ear, and the chronometer microphone was connected to the headphone terminals of the W/T set so that the beats of the chronometer and the W/T beats were heard in both ears.

The Marconi R.P.11 W/T receiver was most satisfactory. A phasing unit to cut out interference was also taken out, but was never used, as the signals were always received so loud, using only the frame aerial, that it was often necessary to cut down their strength to hear the chronometer beats.

On two occasions leads became unsoldered inside the set, but otherwise hardly any trouble at all was experienced. The set is scarcely suitable for camel transport unless packed in a substantial wooden case with plenty of padding to counteract jars when loading and unloading. The H.T. batteries are unnecessarily large and heavy. They did not last any longer than Hellesen ones about a quarter the size, which were employed in West Africa, a much worse climate for batteries. The Siemens inert dry cells did extraordinarily well. When new they would supply the filament current of the W/T set for about three months; they were then employed for a further two or three months to work the chronograph and microphone circuits.

Although the Marconi W/T receiver is an excellent instrument and most reliable, the set used in the Gold Coast was equally satisfactory and cost about one-fifth of the money. It could be carried by one man, complete with all accessories and spares for nine months. The Marconi set is a full camel load without spares, and would take at least three men to carry it.

The Mercer Sidereal Time chronometer gave no trouble at all. It was carried by hand normally, but occasionally in a six-wheeler. It was fitted with a device for stopping it during transit. This device locks the balance wheel and so renders the long hairspring, necessary for a one-second beat, less liable to damage. The one-second beat is not really a great advantage over a half-second beat, for the half-second chronometer can easily be made to mark whole seconds only on the chronograph. If anything goes wrong with the microphone circuit it is much easier to observe the time signal by the eye-and-ear method if the chronometer beats half seconds than if it beats whole seconds only. Either a half or a whole second beat is essential for taking the Rhythmic Signals. A half chronometer or watch is useless.

The rate was very steady over twenty-four hours at any particular place, but there was a distinct tendency noticeable for it to be higher during the night than during the day. The rate also became greater after crossing the Al Hills and descending to the sea. This increase was maintained on recrossing the Al Hills.

The Mercer tape type chronograph was a great success. With reasonable care to see that the pens were adjusted level with each other, and kept clean and filled with ink, no trouble whatever was experienced. The machine was stopped while changing face on the theodolite; this saved a considerable length of tape and reduced the time spent in filling and winding the machine.

Theodolites.—The Watts M.M. Theodolite (Tavistock Model) has already been the subject of a paper at the R.G.S.; a few notes of its performance in the field may however be of interest. The Somali will not carry anything if he can help it, and is quite incapable of carrying anything at all heavy. This small instrument was therefore invaluable in Somaliland for triangulation and the traverse along the boundary.

For astronomical work it was not a success. The bubble is nothing like sufficiently sensitive to produce any reliable results. It is absurd to read the elevation of a star to 1″ and have a bubble which only reads 17″. Although one can set the micrometer so that one repeatedly gets the same reading within 2″ or 3″, the telescope is not sufficiently good to lay on the same point with anything like this accuracy. The prisms for illuminating the circles are fitted in such a way that it is often impossible to get any light on the circle, when one has to observe at dawn or sunset, as in Somaliland.

Although the theodolite was used throughout the two years, for most of the time the readings on the vertical circle were extremely awkward owing to some displacement of the indicator marks. Unless one was used to this defect one was almost certain to get the reading 10 minutes wrong. Dirt or fungus practically obliterated the seconds scale on one face. The electric lighting equipment, although quite good in its way, was nothing like as satisfactory as an ordinary flash-lamp torch and is not worth its cost. The switch and resistance should be on the theodolite to be of any use, not in the battery box. One of the best things about the instrument is that one can use it in the day-time without removing one's helmet, owing to the length of the micrometer eyepiece.

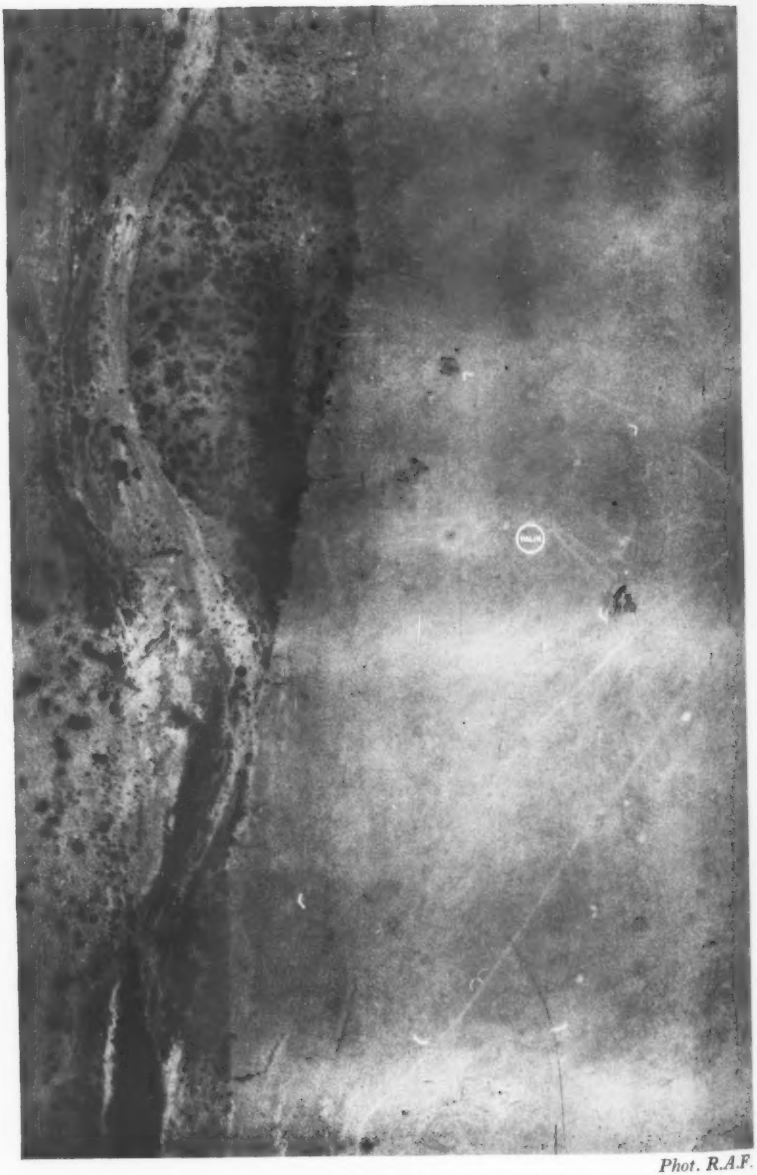
The Cooke, Troughton and Simms 5-inch Theodolite was a standard instrument except that it was packed in one box instead of two, which was a mistake for Somaliland. In West Africa it was a light load for one man and much easier to carry in one box. In Somaliland it would have been more useful in two boxes, as the Somalis could not carry it more than a short distance. It was therefore necessary to carry it on a camel in its tin-lined packing-case to the foot of a hill, and then unpack it and carry it by hand to the top. It was used for most of the astronomical work and also for trig. stations near the camp.

The Cooke, Troughton and Simms 8-inch Theodolite is a beautiful instrument,

Phot. R.A.F.

The Al Hills

UNIV. OF MICH.



Phot. R.A.F.

Halin: ground marks laid out for control of air photographs

but too heavy and bulky for general use in Somaliland. It was used four or five times for astronomical work, but then something went wrong with the bubble, possibly some distortion in the glass, and this caused so much waste of time that it was decided not to use it again.

Paulin Altimeters.—Two of these were received when the Preliminary Survey Party were by the sea at Elayu. The daily wave charts were made out there and on several occasions later on. When these instruments were read carefully at least every half-hour and all the corrections applied, the heights obtained agreed extraordinarily well with those obtained by triangulation, especially if afternoon trekking could be avoided. A closing error of 30 to 40 feet is about the worst that can be expected over a three- or four-day march. Using two Paulin altimeters on different routes and taking the mean, the closing error on theodolite heights was only about 4 feet, over about 70 to 80 miles. As an example of the consistency of intermediate readings the two altimeters on one trek of 24 miles were read at several common stations and the heights obtained for these stations by each altimeter agreed within 1 foot in every case. Three smaller Paulin altimeters were received later.

The safety of these instruments depends entirely on a press clip. If this comes undone, the inner part of the leather case and the instrument fall out. If the inner part of the case is sewn to the outer this cannot happen.

The larger (4½-inch dial) altimeters are much more reliable than the small (3-inch) size. One of each fell as described above. The 4½-inch fell from a galloping horse, but not even the glass broke, and after readjustment it gave results agreeing to 1 foot with those of the undamaged one. The smaller instrument was however hopelessly damaged, although it only fell about 2 feet. Parts of both the other small ones broke without any ill-treatment.

Air Survey.—The R.A.F. detachment, lent from Aden for the Air Survey, consisted of 3 officers and about 18 N.C.O.s and men, with 2 aeroplanes, 3 six-wheelers, electric light plant, and a complete developing and printing outfit. This detachment took vertical photographs of a strip of country 5 miles wide along the entire length of the boundary, and in addition, a large number of photographs were taken to assist in making a small-scale map of the grazing areas.

The control marks were accurately fixed along the boundary by ground survey (subtense traverse controlled by triangulation and astronomical observations) and provided the necessary ground control for plotting the map from the photographs. The heights of the marks and intermediate pillars of the traverse were found by theodolite, and, in addition, those of any other points which were likely to be recognizable in the photographs were also found whenever possible. The height control thus provided proved to be the very minimum that was necessary, and should be increased if possible in future work of this sort. It was afterwards found by experience that even if the pilot could have found his way along the boundary without the artificial marks, it was extremely difficult, in a country like Somaliland, to identify exactly a point on the ground from a photograph. The identification on the photographs of a known point on the ground was not easy, but nothing like so difficult.

The R.A.F. detachment arrived at Buran and were ready to start work at the beginning of December 1929. Unfortunately the demarcation of the boundary was a month late in starting, with the result that the marks in the first sector were not quite ready for photography, and throughout the work the R.A.F. were too close on the heels of the ground survey for comfort. In fact, if the detachment had not returned to Aden for the Kharif they would have had to wait several weeks before they could have commenced the photography of the last section. As it turned out, clouds and the Kharif wind prevented the photography being

done till some two months after the demarcation was completed, although an attempt was made to do it as soon as the marks were ready.

The camera employed had a focal length of 7 inches, and each photograph covered a square of about 4000 yards side, when the camera was about 12,000 feet above the ground. Consequently, in order to cover the 5-mile strip of country it was necessary to make three photographic runs. The centre run was made first, and then one on either side. Normally about 15 miles of the boundary was photographed in one flight, but the standard film of one hundred exposures was capable of dealing with twice this distance if necessary, allowing for a 60 per cent. forward and 25 per cent. lateral overlap.

The camera was calibrated at Buran and Halin at the commencement of work at these aerodromes. This calibration should have been carried out more often, but owing to various circumstances this was impossible. The method employed was to take two identical horizontal photographs on the ground, one with the instrument panel of the camera upwards and one with it at the side of the camera. A theodolite was then erected in exactly the same position as that previously occupied by the lens of the camera, and the angles subtended at the theodolite by five marks, which appeared in the photographs, were observed. From these angles it is possible to calculate the position of the Principal Point.

Developing and printing was carried out in the field as soon as possible after the photographs were taken. An experiment made at Berbera, in which the photographs were taken above the town and then flown over to Aden for developing, proved that the film was completely ruined by the time it was developed. It was therefore essential for the R.A.F. detachment to work from landing grounds where a really good water supply was available. Buran, Halin, and Las Anod were chosen and samples of the water at these places were sent to Aden for analysis as to whether the water were suitable chemically. The water was always inclined to be too warm for good work, but this does not seem to have caused any serious trouble.

The photographs of the last section of the boundary were only developed in the field and were afterwards printed at Aden. This saved the necessity for an electric light plant. Normally a rough set of prints was available the following morning, and the last few photos of each strip were fitted together as a mosaic and taken up by the observer on the next flight to serve as a map of the starting-point. Two fair copies of prints were made later, one being sent to the ground survey party for annotation and the other direct to England for the use of the Geographical Section at the War Office who constructed the map from them.

Notes for Future Air Survey of a Boundary Line

A great deal of delay and complication can be saved if both nations send out a small survey party, well in advance of the rest of the Commission. (Two officers, a W/T set, and 5-inch theodolite.) The two parties can work along the boundary, fixing astronomical points at about 50-mile intervals or at corners, and agreeing on the position of the boundary at these points. Between astronomical points four separate time and compass traverses can be run without any serious delay. From the information thus obtained a very useful sketch-map may be constructed for the use of the Commission, and at the same time a thorough reconnaissance of the boundary has been made.

One can then decide with reasonable certainty how long the demarcation of each section of the boundary will take, and consequently when the R.A.F. should start work, so that the photography will never quite catch up the marking of the boundary until the end.

The position of the main control points agreed on, the demarcation is com-

menced with the full-sized survey parties: say with three more N.C.O.s. Party A does the first 50 miles and at the same time Party B does the second 50. Whichever party finishes first carries on with the third 50 miles and the other with the fourth 50. As a fair average in open country the line will then be marked at the rate of about 100 miles in one and a half months. The R.A.F. reckon on photographing 100 miles a month, and therefore take half a month less for every 100 miles of boundary. This allows for any necessary moves of the R.A.F. base, bad weather, etc. Consequently, if there are no sectors with thick bush which will delay the ground survey the R.A.F. should start two months later for boundaries up to 300 miles, and an additional fortnight later for every additional 100 miles of boundary.

The main point is that the ground survey should have about 150 miles start, for although the R.A.F. allow a month for 100 miles they might take all the photographs in a week under specially favourable conditions. An example of this is the last sector of this particular boundary. Although from May to November no photographs were taken, the whole 70 miles were actually photographed in three days when favourable conditions were at last obtained.

APPENDIX II.—BOTANY

C. L. Collenette

The vegetation of North-East (British) Somaliland is of the same nature as the trans-African belt of "Thorn Scrub," with a sparse covering of isolated thorn bushes as the chief feature, dry tufted grasses and herbs, and an evanescent herbaceous ground vegetation after rain.

The inland plateau, already described in Colonel Stafford's paper, exhibits two fairly distinct types of flora: (1) that of the limestone and rocky country; and (2) that of the sandy soil which extends over the greater part of the area.

The former, which has the more varied flora, is dotted in many places with low-growing clumps of a member of the *Chenopodiaceae*, having small red flowers, which is apparently a new genus and species. Dominants among the thorn bushes are *Balanites orbicularis* Spr., *Acacia misera* Vatke, *Acacia spirocarpa* Hochst., and *Acacia Bussei* Harms. The bright green leaves of *Zygophyllum Hildebrandtii* Engl. are conspicuous after rain, while *Sarcostemma viminale* R. Br. and *Aloe percrassa* Tod. are prominent among the succulents. Grasses are not a feature of this area, but *Schizachyrium Kelleri* Stapf. forms occasional large clumps, and *Elusine Robecchii* Chiov., with its rigid and prickly leaves, is abundant away from the tug beds. *Tamarix nilotica* Ehrenb. is common wherever it can find sufficient moisture.

In sandy soil grass appears more extensively. Vegetation is fairly heavy along the lines of the tugs, and sparse on the higher ground. *Acacia spirocarpa* is the only common tree, and frequent bushes of *Cadaba mirabilis* Gilg. occur. *Tamarix nilotica* and *Zizyphus Hamur* Engl. are common in the neighbourhood of the tug beds, with the grasses *Amphilophis radicans* Stapf. and *Pennisetum orientale* Rich. A mixed growth of other grasses often covers the surface for considerable distances, on the higher ground as well as on the lower.

Mention should be made of the edaphic vegetation dependent on the presence of permanent water, of which there are several instances in the area under review. Seepage cliffs above a rocky pool are usually covered with a growth of the maidenhair fern *Adiantum capillus-veneris* L., and near the water numerous species of rushes and sedges occur. In the oasis of Karin, Italian Somaliland (lat. 10° 57′ N., long. 49° 24′ E.), and also at Marojeh in the Al foothills, where

marshy ground covers a small area, there is a growth of the tall Madah palm, with undergrowth of *Phoenix reclinata* var. *somalensis* Becc. and a species of *Pluchea*.

The flora of the coastal range is of considerable interest. A visit of four weeks was made by the writer to the Al, in the neighbourhood of the boundary, where the hills attain a height of 6250 feet, and another visit of sixteen days to the Surud Ad, 120 miles west of the boundary, in lat. 10° 45′ N., long. 47° 12′ E., where a height of 7250 feet is reached.

The north-east monsoon coming in from the sea impinges on the steep northern slopes of the range, resulting in considerable rainfall and cloud. On the more gently sloping southern side, heated by the sun, the rainfall very rapidly diminishes, and the lower slopes are reached only by occasional storms.

On the slopes which fringe many of the southern valleys of the Al up to 3500 feet, the sparse flora is largely composed of the frankincense tree *Boswellia Frereana* Birdwood, the Yigaar which yields the Maidi gum. It is not as a rule to be found on level ground, and is not often seen above 3750 feet. Together with the less common and inferior *Boswellia Carteri* Birdwood, it is extensively exploited for its gum by the Warsangeli, who live in the hills. The trees are protected from harm and are never cut as firewood, and are left untapped until they attain a considerable size, but no attempt is made to increase their number.

Leaving out of consideration some minor types of vegetation at different heights, the zone which occurs from 3750 feet to the top of the southern slope of the Al, with sparse soil and full exposure to the sun, is characterized by a growth of low-growing succulents, among which are three species of *Euphorbia*. The curious *Trematosperma cordata* Urban, with its very large exposed rootstock, is also prominent.

The highest zone on the Al is marked by an abrupt division from the last mentioned, stretching across the broad summit of the range, at heights varying from 4000 to 6250 feet, and down the northern slope to about 3000 feet. It occupies the site of greatest rainfall, and is sheltered throughout much of the year by clouds. Other factors are the more oblique rays of the sun on the northern slopes, and the lower temperature due to elevation. A Box tree, *Buxus Hildebrandtii* Baill., clothes this area in almost unbroken cover, and makes up perhaps 90 per cent. of the larger vegetation. In its shade, and growing in the deep humus derived from its fallen leaves, is a carpet of small and delicate herbaceous plants and ferns, of numerous species. On the level floors of the valleys which intersect the summit are green lawns of *Cynodon Dactylon* Pers. with a few large trees of *Ficus gnaphalocarpa* A. Rich., under whose shade in the grass are numerous plants of a new species of *Merendera*, with crocus-like flowers.

On the Surud Ad mountain somewhat different conditions prevail. Briefly, *Buxus Hildebrandtii* does not appear on the mountain, but on the broad summit, at an elevation of 6500 to 7250 feet (not attained on the Al), and covering the area of greatest rainfall down to 6000 feet on the northern slope, is an almost continuous forest of the cedar *Juniperus procera* Hochst., covered with long grey streamers of the lichen *Usnea articulata* Hofm. form *trichodioides*. There is considerable undergrowth of a new species of *Sideroxylon*, *Cadia purpurea* Ait., and *Dodonaea viscosa* L., while the green lawns of the valley floors are again to be noted.

Domestic animals—camels, sheep, and goats—undoubtedly affect the composition and development of the vegetation in the principal grazing areas of the inland plateau country, where edible species are handicapped as against protected and poisonous species. Moreover, in times of drought, the practice is frequent of cutting and bending over the stem of *Acacia* and other bushes to allow the animals to graze on the upper branches. The effect of domestic animals

on the vegetation has been varied in the past by the fluctuation in their numbers, owing to the unsettled condition of the country. Although periodic drought is a controlling factor, under present more settled conditions a considerable increase in flocks and herds is to be expected, with an even greater influence on the vegetation.

Native names were obtained for the great majority of the plants collected, and in a number of cases the meaning of the name was also noted, throwing light on the uses and attributes of the various species. In this connection the writer would like to acknowledge his indebtedness to Major Horsley, whose knowledge of the language proved invaluable.

It was found that, while all the Somali tribes speak the same language, plant names in use by one tribe may vary considerably from those of another, and furthermore that the name of a common plant in one part of the country may be transferred to another species in some other locality.

Speaking generally, the plant names may be separated into two classes, those used by the Darod tribes (Warsangeli, Mijertain, Dolbahanta, etc.) and the Ishaak tribes (Habr Yunis, Habr Awal, Habr Toljalla, etc.). In some cases however it was found that individuals were acquainted with both sets of names, and appeared to use them indiscriminately.

It is hoped that a full account of the botanical work will be published in the Kew Bulletin during the present year.

DISCUSSION

Before the paper the PRESIDENT (Admiral Sir WILLIAM GOODENOUGH) said: It is almost a truism to say that one of the most important things which we encourage in this Society is accurate survey, and it is certainly true that one of the most important parts of accurate survey is the demarcation of boundaries. We are to hear to-night an account of the demarcation of the boundary between Italian and British Somaliland. The work was carried out by a Commission composed partly of Italian officers, partly of British. The Italian Commission was led by Commendatore Cerulli, whom we hope to hear speak a little later, and I take this opportunity of saying that it is a great pleasure to us to welcome him and three of his colleagues among our audience to-night. At the head of the British Commission was Colonel Stafford, who will deliver the lecture this evening. He was assisted by two other officers, one a Sapper and one a Gunner—I believe I ought to say one of the Royal Engineers, one of the Royal Artillery—and a geologist, Mr. Barrington Brown, to whom we shall also listen later. Without more ado I ask Colonel Stafford to deliver his lecture.

Colonel Stafford then delivered the lecture printed above, and a discussion followed.

The PRESIDENT: Mr. Barrington Brown was geologist to the expedition. He has brought some slides here and I will ask him to say a few words and show his slides now.

Mr. BARRINGTON BROWN: I have a few slides showing the geology of the 49th meridian from Buran to the sea-coast. The oldest rocks are slates with intrusive sills of Palaeozoic age, but nothing more definite is known about them. Upon them rest Jurassic, Cretaceous, and Eocene rocks, the Eocene forming the surface of the crest of the Al Hills and all the country to the south. The whole country of the Al Hills is heavily faulted. As you go farther south after passing over the Al Hills you come to the Sorl Haud plain about 3000 feet above sea-level. The rock forming the country here is entirely Middle Eocene. Practically all these Mesozoic and Tertiary rocks are limestones. On the coast there is a small

range of hills about 500 or 600 feet high composed of Lower Eocene rocks. There is a coastal plain which has been upraised about 15 feet.

One can divide the district into three areas: that of the sunken block of the Aden Gulf, that of the faulted area of the Al Hills, and that of the folded Tertiaries of the inland plateau.

One of the most interesting things about the geology of this part of the world is the Great Rift fault which runs up Africa. A branch from this, running east and west, is supposed to have given rise to the Gulf of Aden, and I was able to find this rift fault on the ground and trace it about 45 miles, from the political boundary westwards. The inclination of the fault is 45° and the throw is about 6000 feet—*i.e.* a bed on the north side of the fault will be found about 6000 feet below on the south side. It is likely that farther out to sea there is another parallel fault giving rise to the great depths of the Gulf of Aden.

Another interesting geological phenomenon in the Sorl Haud plain is the occurrence of a large number of small synclinal basins, most of which are about ½ mile to 1½ miles in diameter and which can be likened to a nest of pie-dishes, each pie-dish being a bed of limestone. There are numbers of these synclinal basins, and I have not been able to give a completely satisfactory explanation of them. I should point out that owing to a large fault Middle Eocene beds have been preserved in the neighbourhood of Marojeh, and this fault is of particular interest because, as it changes direction, from west to west-north-west, it splits up, in turning the corner, into four separate faults. The throw of each fault, in turn, is 2000 feet, dying away to nothing.

I show you an air photograph on which the course of these faults can be clearly seen. At Marojeh the faults are shown on the surface as great cliffs of hard Marojeh limestone: the formation of deep ravines in this limestone is also very clearly seen. Another view shows the Galweineh tug, and the difficulty of travelling along the tug can be imagined when I tell you that you have to pass huge blocks of this limestone which have fallen down from the cliff walls. One fallen block shown in the slide is almost a perfect cube of about 2500 cubic yards in volume.

The diagram of the synclinal basin depicts the out-cropping edges of different limestone beds, and I think, with some imagination, you can regard them as like pie-dishes one inside the other. The photograph of the surface of this same basin shows the outcropping edge of the limestone, and the air photograph of one of the basins shows it to be slightly irregular. The axis of nearly all these basins is north-west and south-east. You will notice thin white lines which represent thin limestone bands of lighter colour, forming minute escarpments. You have already seen what we term the "Cottage Pie," and although it is carved out of exactly the same beds—originally, of course, horizontal limestone beds—you get apparently two quite different types of denudation: *i.e.* almost conical hills and this curious formation. A view of the sea-coast shows a fairly modern coral and shell consolidated beach. The surface of the top of the beach is about 15 feet above sea-level and is being rapidly undercut by the sea all along the coast.

Commendatore CERULLI: I can add only a few words to the interesting lecture by my colleague and friend, Colonel Stafford. I say "friend" because two years spent together in demarcating a boundary in Somaliland is, I think, quite sufficient reason for friendship. I should like to point out, in the light of our experience, that the colonial powers, when they settle the question of their boundaries and of their good neighbourship in Africa, would be wise to inquire beforehand as to what are really the rights and claims of the native tribes in the area concerned. In this case "inquiry," I think, cannot mean, as it sometimes does, questioning the natives and putting on record all that they say. On the con-

trary, it means in our sense questioning the chief natives and men of importance and checking their statements through real experience gained by white officers on the spot. I will conclude by expressing my gratitude and that of all the other officers of the Italian section to you for your kind invitation. We are really proud that our work in Somaliland has resulted in the honour of being invited to a meeting of the Royal Geographical Society.

The PRESIDENT: Sir Charles Close is a Past-President of this Society and a past-master in the art of demarcation of boundaries. I call upon him to address us.

Colonel Sir CHARLES CLOSE: I think that we have listened to-night to the first exposition of a new method of boundary demarcation. I am very well acquainted, as many present are, with the old methods which were very straightforward, and which some of us hoped would last for ever, until indeed the world became completely unified and there was no need for boundary commissions. But as a fact here we have a new method. The use of aeroplanes has made the actual description of the topography a good deal easier than it was, though actually more limited. In this instance I understand the Boundary Commissioners carried out the survey of a strip about 5 or 6 miles wide. That is rather narrower than used to be the custom, but, on the other hand, the detail of the work was a good deal better, because it is possible from air photography to get a good deal more information than from the rather scrappy sort of plane-tabling which a boundary commission enables you to do; not that plane-tabling is a bad thing; it is very good indeed, but there is not, as a rule, time to carry out an elaborate survey on a boundary commission.

Colonel Stafford did just indicate that they made marks along the boundary —crosses, triangles, and so on—and I understand that those were picked out without any difficulty on the air photographs. That method no doubt will be extended. You may not only make the marks but make them so big that you can actually measure the scale from them. There is a prevailing delusion that it is possible to make small-scale photographs from the air. It is not. It is however possible to make medium-scale maps from air photographs, giving something of the order of 2 or 3 inches to the mile. About thirty years ago, or so, it was not unusual to make boundary commission maps on the scale of ¼-inch to the mile, but these air photographs give you 2 or 3 inches to the mile. That is a very different thing. It is not, in fact, possible to get high enough in the air to make a sufficiently small-scale photograph, though what you can make is exceedingly valuable. Anyway, this is a new technique, and it is coming rapidly into use. I should think in many future boundary commissions we shall have flying men taking photographs; and, bit by bit, I suppose, the mere ground surveyor will tend to become less indispensable; he will find his trade gradually leaving him. On the other hand, we should not forget one thing that the lecturer mentioned: the man in the air cannot find out what the names of the places are.

The PRESIDENT: I do not propose, from a professional point of view, to add anything to what Sir Charles Close, who, as I say, is a past-master in the art of demarcation of boundaries, has said except to agree very strongly with all he says about the air. The Society has a Sub-Committee sitting now discussing air navigation and air survey, and Great Britain, in common with all other countries, has got to set to work to see that the most is made of that addition to navigation and survey. I am given to understand that the instruments used by the British-Italian Boundary Commission, especially the three theodolites, will be dealt with in Appendices to be printed in the *Journal*, and I hope that those who study such subjects will be interested to hear the remarks, and in some cases the very useful criticisms, that will be made by the officers of the Commission in regard to some of the newer instruments.

We would willingly during the course of the lecture have heard more about the people. They are a very hardy and courageous race. Colonel Stafford told me of an instance he came across of a man with his two women folk guarding their herds attacked one night by a leopard. Between the three of them they strangled the leopard with their own hands, but in doing so they suffered terrible wounds. He came upon them some months afterwards and was able to render medical assistance. When he saw them their wounds were still covered with gum obtained from the trees. However, they all recovered. I quote that as an instance showing the fortitude of the people.

There is one thing that has been rather upset by Colonel Stafford and the other members of the Commission, and that is the map of Somaliland. If you look at the map in the Map Room you will see that it is all covered with round marks, some big, some small, put in and marked as big places. I am given to understand that these places are no more than a few huts. We have heard of a place which is very little known to most of us, and a very interesting place too. I imagine the majority of people thought it was a comparatively flat country. Certainly I had no idea that there was so much water and scrub and pasture. I ask you to accept, Colonel Stafford, on behalf of this audience and of the Royal Geographical Society, our very great thanks for giving us a most interesting and instructive evening.

Dr. W. A. MACFADYEN *sends the following note on water supply in Somaliland:*

Perhaps I may be permitted to add some remarks about the water supply in the eastern part of the plateau of British Somaliland, a subject in which every traveller there is perforce interested. Rain-water is used so long as it lasts, from slight depressions which form ponds after rain, and are called ***ballehs***. This water is perfectly sweet, but often muddy, and the ballehs become filled with algae and so on, though nobody minds that. The ballehs in the east seem to be all natural, but I heard from a Somali in the Haud to the south that a noted man is sometimes commemorated by digging a new balleh, which is called after him, and I have seen certainly one artificially improved balleh there: an excellent form of memorial, but perhaps hardly of universal application.

The more or less permanent well-water is commonly anything from 1 to about 20 feet below ground-level. It is bailed out in raw-hide (or partially tanned) buckets called wadans, well adapted to their purpose, as they are light, capacious, and not easily damaged by striking the walls. During the watering of cattle from deep and wide wells Somalis form a chain of men along which the wadans are passed. The filled wadan is lifted shoulder high fore-handed; it is then twirled rapidly and passed on back-handed to the next man, sometimes even when the latter is on the same level.

With the exception of the few red-letter wells of good water in the Lower Eocene limestones the quality of the well-water is poor. It varies from well to well, from the sort that can be imbibed neat by the thirsty Briton (though without enthusiasm) to the sort at which even a camel draws the line. The bad quality is due to two things, first to the gypsum in solution, derived from a bed in the Middle Eocene up to 1000 feet thick, and which lies at the surface in wide and often bare plains in the Nogal and round the edges of the Sorl Haud*; and secondly, to the common occurrence of sulphuretted hydrogen in it, in quantity amply sufficient both to smell and taste. Neither Somalis nor their flocks object to this, nor does it seem to be unwholesome, but in certain wells that have not been used for some time it appears to accumulate in quantity sufficient to gas and kill a man, and I am told that this is by no means an unusual occurrence. For

*See note on page 113.

The Mullah's fortress of Silsilat

UNIV. OF WICH.

Dar Ilalo and Taleh Tower

Taleh Tower and Tomb of 'Abdullah Hasan from Dar Ilalo Tower above granaries

some time I was puzzled to account for this sulphuretted hydrogen, but eventually came to the conclusion that it was due to the chemical reduction of a part of the dissolved gypsum by organic matter actually in the wells, probably through bacterial action. This organic matter is the dung of the various cattle, partly blown in in dry weather and partly washed in as a foul black stream during watering operations. To save labour the watering takes place as close as possible to the wells, and as these are frequently found in solution cavities in the gypsum country rock, the ground often slopes down towards them, and any spilt water trickles back into the well. One day I pointed this out to a Somali, and suggested that it would be better if they took steps to prevent it. He answered that on the contrary it was a very good way to conserve the water supply.

TALEH

W. A. MACFADYEN

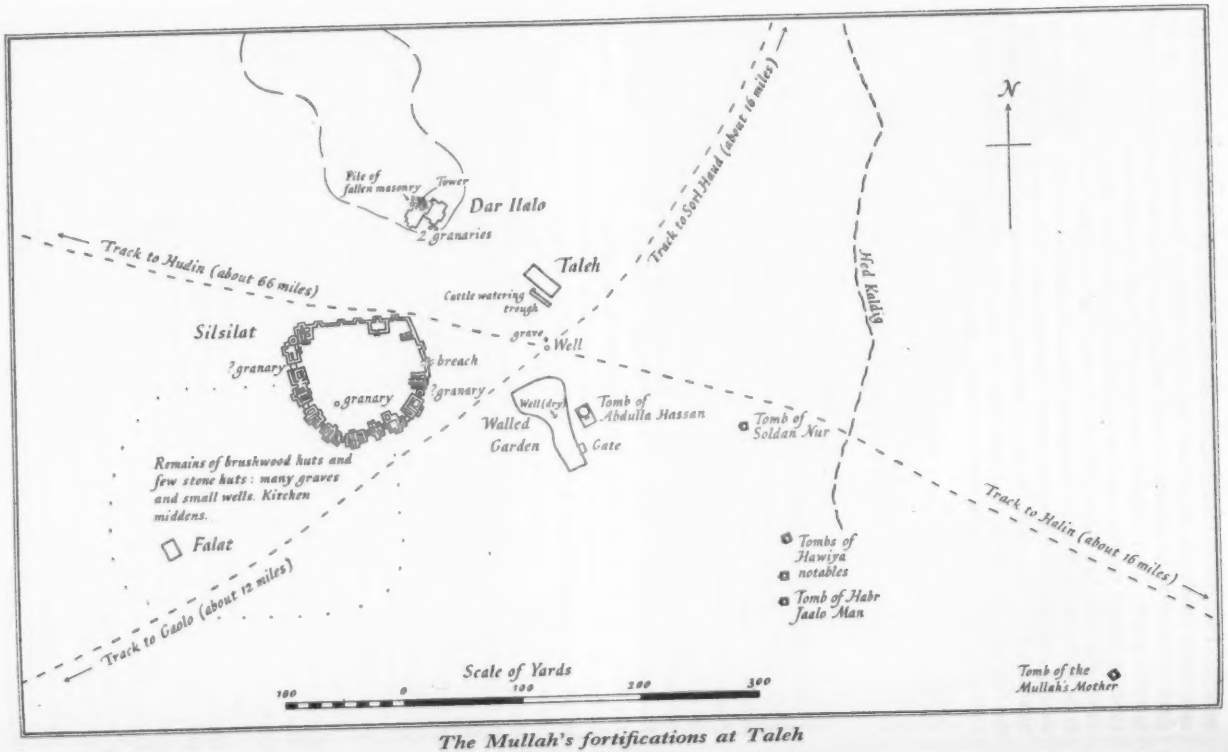
JARDINE* has written the story of Muhammad bin 'Abdullah Hasan,† the "Mad Mullah" of Somaliland, and of the series of British campaigns against him. I have been unable however to find published any detailed account of the remarkable stronghold built by him as his headquarters at Taleh, in the eastern part of British Somaliland, in lat. 9° 9′ N., long. 48° 25′ E., which it is the purpose of this note to describe. Since it is an out-of-the-way spot it is rarely visited by Europeans. The very brief official account of the last operations (*The Times*, 18 February 1920, p. 9) only mentions the place, while a further note (*op. cit.*, p. 15) refers to it as a walled town surrounded by thirteen forts. A few air photographs taken by the R.A.F. during the aerial bombardment of 4 February 1920 were published by the *Illustrated London News* and the *Sphere*, both of 17 April 1920, and in the latter a short account of the place was given, obviously written up from the air photographs alone; this was reprinted by Jardine (pp. 282, 283). The writer found an interesting mare's nest in his speculations as to the probable great antiquity of the buildings. Jardine reproduced two of the air photographs and added a single ground photograph. That he is not literally accurate in his statement (p. 283) that the place was "razed to the ground" is shown by the present photographs, taken in 1930.

The topographical data for the accompanying plan, and some of the photographs, were most kindly placed at my disposal by Lieutenant Taylor, R.A., who visited Taleh in 1930 during the work of the Anglo-Italian Boundary Commission.

Taleh is by far the largest and most impressive fortress constructed by the Mullah, though he built a number of smaller forts in the country eastwards from Shimber Berris in the Bur Dab range in the Ain country as far as the present frontier or beyond; they were all partially or wholly destroyed by our Forces. Having camped there for one night I spent some time examining the place, and noted down the information obtained by questioning the Somalis of my staff. Three of them were or had been Camel Corps reservists, and two

*Douglas Jardine, 'The Mad Mullah of Somaliland.' 8vo. London 1923.

†This is the more correct transliteration of the name which appears on the map as "Abdulla Hassan."—Ed. *G.J.*



The Mullah's fortifications at Taleh

claimed to have been present at its capture by our tribal levies on 9–10 February 1920. They seemed sure of what they told me, and I have no reason to doubt that it is substantially correct.

Taleh is situated at an altitude of about 2000 feet, in open, treeless country, some 15 miles south of the main southward-facing scarp of the Sorl Haud plateau. The country rock is gypsum (or more correctly anhydrite) of Middle Eocene age, which outcrops extensively round about, and forms the material, collected on the spot, out of which the buildings were constructed; when burnt it probably yielded the plaster to cover the tombs and for other purposes. The strata are flat-bedded and form a few erosion hillocks, on one of which is built the look-out tower, Dar Ilalo.

Muhammad bin 'Abdullah Hasan is said to have commenced building Taleh about 1913; prior to this there were no buildings there. It was built under the supervision of Yemeni Arab masons engaged for the purpose, possibly with a Turk as architect, though on this point I have found no good information. The walls are built of unshaped blocks of anhydrite, some weighing 150–200 pounds, but mostly smaller, with some rubble infilling. The blocks are very well set in a mortar of mud mixed with dung. The lintels of doorways and openings are made from small tree trunks of a particular hard wood. A profusion of these has been used, and must have meant widespread collection in the country.

The plan shows the general location of the buildings and the name of each, as given to me by my Somalis. The main fortress, Silsilat, is about 350 feet long by 300 feet broad. At the breach on the east side, made by the Camel Corps, the wall at the base is 8½ feet thick. The walls of the strong points on the south side, clearly intended to be the front to be attacked by an enemy, are about 35 feet high. The north side is by no means so strongly fortified, and serious attack does not appear to have been contemplated from there. A curious point is the absence of a gateway to Silsilat; how entrance was effected is not quite clear. One is left with the feeling that the Mullah must have built it largely as a show place, both to flatter his vanity and to increase his prestige, rather than purely for defence.

The two buildings next in importance are Dar Ilalo, the look-out tower, some 50 feet high, built on the top of a hillock close behind Silsilat, and Taleh (in a restricted sense) of similar height, built on lower ground to the east. The latter was built over a well, and a large plastered watering-trough for cattle is still intact and stands close outside. This well is now closed by the wreckage of the tower, but a cave-well lies 50 yards to the south, close below a pile of rocks marking a grave, and at a couple of feet below ground-level yields a large supply of somewhat gypseous water smelling of sulphuretted hydrogen; this seems to be the best water available in the district, and is now largely used by Somalis. Water underlies much of the ground at a shallow depth, and many small wells with water still in them are to be seen inside Silsilat, particularly in the western part, and outside towards Falat. A Turk and a German are said to have had their quarters in Taleh tower; the history of the latter unfortunate is given by Jardine (pp. 247, 248).

Falat is said to have been the dwelling-place of 'Abdullah Hasan's wives, and between Falat and Silsilat the ground is covered with the remains of brush-

wood huts, graves (of "people who died hisself," as one Somali put it), small shallow wells, and kitchen middens.

A curious feature of the buildings is the conical towers; two are seen at the corner of Dar Ilalo, one is isolated inside Silsilat, and there are possibly two (left unfinished) built into the outer walls. These are granaries, and the only opening is close to the top, through which a man may climb. The openings are reached by a series of rude stone steps projecting from the outside (and probably from the inside) of the wall of the tower. Mr. Taylor tells me that he found a considerable cultivated area about 3 miles to the north-east, where jowari had apparently been grown by the Mullah.

South of the main cave-well is the considerable tomb of 'Abdullah Hasan senior, well plastered inside and out; it is now said to be empty. Adjoining this on the west is a walled garden with massive gateway and guard-house; the rest of the wall is not more than 5 feet high and plastered. There are still odd bushes and signs of cultivation to be seen, but the comparatively deep well in the middle is dry. To the east lies a row of four tombs. The most northerly is that of one Soldan Nur of the Habr Yunis tribe; the next two, neither being plastered, and the first with the top left unfinished, are those of Hawiya notables whose names my Somalis did not know. The most southerly tomb is that of a man of the Habr Jaalo tribe. The isolated tomb still farther east is that of 'Abdullah Hasan's mother. All the tombs are provided with narrow but very massive wooden doors, swinging about vertical extensions from top and base of one side.

A little east of Soldan Nur's tomb is a shallow nulla, seen as a dark line in the photograph, and known as Hed Kaldig, the Place of Blood. This was the execution ground where those to whom the Mullah had taken a dislike were shot, with or without torture. Had such anticipated trouble and escaped, any members of their families on whom hands could be laid, including women and children, are said to have been shot in their stead, and their bodies left for the hyaenas. After the capture of Taleh pious Somalis collected the quantities of human bones found hereabouts and gave them burial. However this may be there are no human bones about now.

According to Jardine the R.A.F. bombed Taleh on 4 February 1920, and set fire to brushwood huts inside and outside Silsilat, but did little damage to the main structures, which is not surprising. The place was attacked by our tribal levies under Captain Gibb on the evening of February 9; 'Abdullah Hasan had already fled, and by the morning of the 10th the levies were in complete possession. A detachment of the Camel Corps remained for two or three weeks to demolish the fortifications. Dar Ilalo, Taleh, and Falat were severely damaged and made unusable, and the strong points fronting Silsilat were partly destroyed. Razing such a structure would have required much further work and explosives, so that a considerable part has been left with little damage. It will remain as a relic of that rather remarkable person its builder, the only Somali who has so far created substantial buildings in his country.

THE EFFECT OF WAVE INCIDENCE ON THE CONFIGURATION OF A SHINGLE BEACH: *A paper read at the Afternoon Meeting of the Society on 16 March 1931, by*

W. V. LEWIS

THE Royal Commission on Coast Erosion and Foreshore Protection 1907 showed a very marked difference of opinion concerning the relative merits of waves and currents in causing the drift of shingle along a coast-line. Since that time, chiefly as a result of the work of Johnson in America and Owens and Steers in this country, opinion has turned in favour of waves. The precise nature of the action was first described by Palmer* in 1834. When waves break obliquely on the beach the swash† drives the shingle up the beach in the direction of its motion. The backwash then returns down the line of greatest slope, that is, directly down the beach, carrying the shingle with it. A series of such waves will therefore cause the shingle to travel in a zigzag path along the beach. The breakers, acting through the swash, always impel the shingle towards the shore; it is only the slope of the foreshore that, on a graded beach, enables the backwash to return this shingle an equal distance down the beach. When a coast-line is fairly straight, therefore, the shingle should always tend to lie against the bottom of the cliff.

On the Norfolk coast the shingle ridges ending in Scolt Head Island and Blakeney Point leave the old cliff at a small angle and end at a point some distance from the mainland, partially enclosing a backwater. There is no river mouth or bend in the shore-line to explain the departure of the shingle from the main coast when the spits first began to form. This suggested to me that there might be an action of the sea on shingle other than that of drifting by obliquely impinging waves.

With these problems in mind I visited the more important shingle formations of the South coast in the summer of 1929, including the Chesil Beach, the Portland and Weymouth Beaches, Hurst Castle and Calshot Spits, Selsey Bill, and Dungeness, together with several minor beaches along the Glamorganshire coast. After an examination of these features presenting such variations in size and exposure, the points which impressed me were the beautiful curves of the main ridges and the marked parallelism between these, the minor ridges, and the line of breakers. On the Chesil Beach I observed the lowest ridge being built up by the swash of the waves breaking directly onshore. Looking up the beach at the ridges rising 30 or 40 feet above, I visualized the immense storm waves which had built them, and this led to the suggestion that these waves might have influenced the direction of the ridges which they had built. That they had, was suggested by the fact that the Chesil Beach faces south-south-west, the direction both of the greatest stretch of water and the most powerful winds, and there seemed to be no other obvious reason for the bank taking up its present direction to Portland.

At Weymouth, Hurst, Calshot, and Dungeness further instances were provided of beaches lying in the direction opposed to the greatest stretch of water.

*H. R. Palmer, "Observations on the Motion of Shingle Beaches," *Phil. Trans.*, 1834.

†The "swash" is taken as the rush of water up a beach from the breaking wave.

Thus the action which had first attracted my attention at Scolt and Blakeney seemed to be the one by means of which the sea can build shingle ridges in the direction of the most powerful (dominant) waves. It was with such a working hypothesis that I made the researches here described.

Out of a copious literature on the subject the only reference which dealt in any detail with an action of the sea other than those of longshore currents or obliquely impinging waves was due to Palmer. He referred to the accumulative and destructive action, but since that time attention seems to have been focussed almost entirely on longshore action. That longshore currents cannot move shingle seems generally agreed, yet the only explanations given for shingle spits and other related features are those which appeal to these currents. This paper will deal first with the action of the sea on a shingle foreshore and then offer an explanation of the manner in which a shingle spit can be built out from the mainland solely by the action of waves.

During a stay at Hurst Castle Spit an excellent opportunity was provided for studying the effects on the beach of waves of various sizes and angles of approach. The beach itself showed all gradations from sand to shingle, and faced directions varying from south-west round through east to north-east. The dominant action of the waves was destructive and constructive, at times combing down the beach and at other times returning shingle to the foreshore in considerable quantities.

*Destructive Action.**—The destructive waves, those which combed down the beach, broke with a frequency of thirteen to fifteen a minute. The lack of uniformity in size and period showed that two or more sets of waves were usually involved. The most striking feature was the weakness of the swash by comparison with the backwash. When the swash and backwash met halfway down the beach the progress of the latter was little impeded; even when the meeting took place immediately in front of the breaker-line, the backwash had frequently acquired a momentum equal to that of the newly formed swash, the result being that masses of water were sent vertically into the air. The effect on the shingle was illustrated by the roar of the backwash rolling pebbles down the beach, this roar being much more penetrating than that of the waves actually breaking. The slope and distribution of sand and shingle on the beach at mid-tides did not always show the destructive action of these waves, but this was easily discernible near high-water mark from the combing down of the ridges at this part of the beach. The swash caused little disturbance, but the backwash started a miniature landslide down the face of the ridge, leaving the slope at the angle of repose for such pebbles.

Palmer noted this connection between destructive action and high frequency, and explained that in such a case a wave invariably breaks on the returning waters of its predecessor. This results in a more or less continuous seaward movement of the water in contact with the beach, thus causing the down-combing. The lack of speed in the waters of the swash, however, was also noted when a wave broke on a foreshore free from water, so the full explanation seems to lie in the nature of these waves which give rise to such a slowly

*The instances here described are ones which showed the destructive and constructive actions respectively, in very highly developed forms, on a foreshore with a considerable gradient and small tidal range.

advancing swash. To one observing the breaker itself the vertical plunge of the water was most evident, and this gives a ready explanation of the weakness of the swash. Fig. 1 represents in profile this type of wave breaking on the beach. The short wave-length, suggested by the high frequency, results in the water possessing a cycloidal motion with a considerable vertical component, roughly circular in the figure. As the wave breaks the water will then fall nearly vertically at B, causing a marked rebound at A. There will then be only a small horizontal component of motion to be transmitted to the swash, the motion of which will be due to a considerable extent to the head of water developed at A. Such an explanation accounts for the gently flowing motion of the swash as well as the vertical plunge of the water in the breaker.

*Constructive Action.**—The finest example of beach-making waves was observed one afternoon when the wind had dropped after an exceptionally boisterous night. They were breaking with a frequency of six to eight a minute and showed the powerful swash and a backwash weakened by friction and percolation, referred to by numerous writers. A previously sandy foreshore was now completely covered by a thick layer of shingle, and at all stages of the tide a small ridge was present at the landward limit of the swash, indicating the continuous return of shingle to the beach. Wherever the collision between the waters of the swash and backwash took place, the former continued but little impeded, and the roar of shingle being rolled up the beach was now most noticeable. Fig. 2 represents the constructive wave; its long wave-length gives the water a motion in an ellipse with the major axis horizontal, so that the waters in the plunge at B possess a considerable horizontal component of motion. This, in being transmitted to the swash, gives it the powerful rush up the beach already referred to.

The beach profiles resulting from destructive and constructive waves are represented in Fig. 3 by AB and CD respectively. The steeper slope near high-water mark in the case of destructive waves is easily visible on the beach. This difference can most readily be demonstrated by the little landslide which results from disturbing the shingle at A with the foot, that at C, however, does not continue to move once the pressure of the foot is relieved. The increase in slope beyond low-water mark at B and D seems due to the strong seaward movement of the water in contact with the beach in the last cycloidal motion before breaking; this action has been described by Cornish.† Let us consider in greater detail these changes of profile: first that from CD to AB, and then the reverse.

As the tide rises with destructive waves breaking on the beach, they begin to remove material forming a profile adjusted to their action, which intersects the original profile at E (Fig. 4). This nick at E becomes more pronounced as it travels up the beach to F, G, and finally to A, always being at the farthest point reached by the swash. With the falling tide material might still be removed from the beach, eventually leaving a low-water profile AB. When these waves were large at high water, in removing material from in front of A they swept some of the shingle over the top, thus increasing the height of the ridge.

Considering the reverse change, let AB (Fig. 5) represent a down-combed

*See note on opposite page.

†Vaughan Cornish, "Sea Beaches and Sand Banks," *Geogr. Journ.*, 1898.

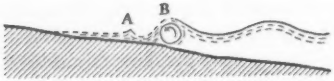


Fig. 1.

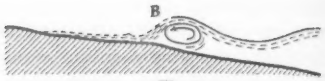


Fig. 2.

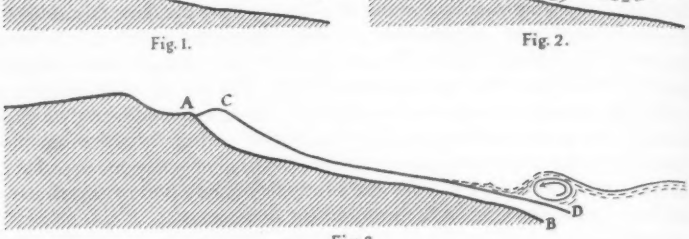


Fig. 3.

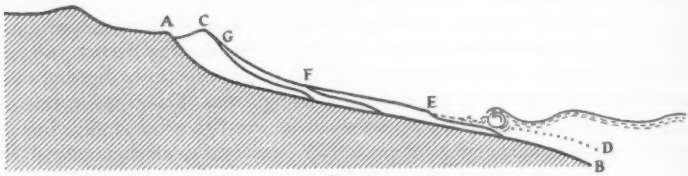


Fig. 4.

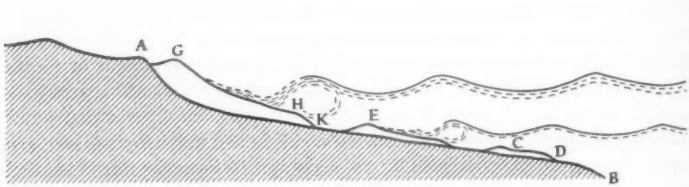


Fig. 5.

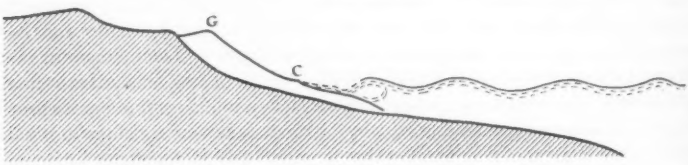


Fig. 6.

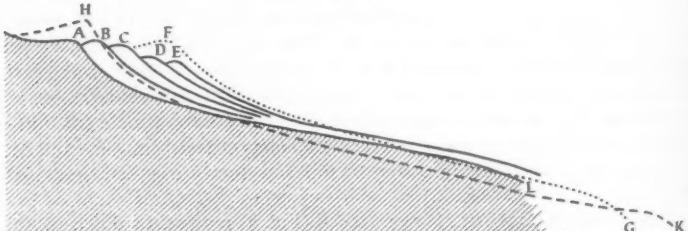


Fig. 7.

beach profile. As the tide rises an addition is made to the beach, first represented by CD and in a later, more developed form at E. The swash carries material up to C which is not returned by the weakened backwash, and this ridge is enlarged as it is driven farther up the beach until it reaches G at high water. The visible profile at high water is represented by GHK, GH being the swash-backwash slope and HK the steeper section always present immediately behind the line of breakers. Both the ridge and this increase in slope travel up the beach with the rising tide, but on the ebb the former remains at the top of the beach whilst the latter retreats with the breaker line. HK always shows its maximum development at high and low water because of the longer period during which the waves are acting at the same level. Fig. 6 represents a stage of the ebb tide when material is still being returned to the beach, resulting in the change of slope at C, above which the foreshore is only very slightly ridged as a result of occasional larger waves washing up more shingle than usual. The profile at low water is formed by the continuation of GC to that level.

Having considered the formation of a single small ridge at G, let us now examine the conditions necessary for the building of a ridge which will be a permanent addition to the beach. These views follow closely those expressed by Vaughan Cornish in the paper already referred to. Let AL (Fig. 7) be the beach profile as a result of destructive waves at spring tides. During the ensuing period of ordinary and neap tides, suppose constructive waves to be prevalent, so that ridges B, C, D, and E are added. If constructive waves accompany the next spring tides a large ridge F may be formed with a low-water profile FG. To preserve this ridge a continuation of beach-making conditions would be required, which necessitates both a remarkably long period during which these waves prevail and a very large supply of shingle beyond the low-water mark. As such a combination of circumstances seems unlikely, this ridge would probably soon be eaten into and its shingle redistributed. This formation and removal of temporary ridges must be a very usual action of the sea.

Suppose, on the other hand, that moderately large storm waves accompanied the spring tide following the building of ridges B, C, D, and E. Such storm waves, the product of powerful onshore winds, would probably have a very vertical orbit on breaking. This is suggested by the down-combed nature of the profile of the upper ridges at Chesil and also the frequent references to the beach-removing action of great storms. The greater part of the material composing the ridges B, C, D, and E would then be combed down, but a certain amount would be thrown back by the swash of the waves overtopping these ridges, to form a large ridge at H. During succeeding tides with quieter weather, waves would return a lot of the material swept down to the neighbourhood of K, to form small ridges in front of H. This would tend to be the case because the profile would need readjusting to these smaller waves and because, being in all probability the swell of the storm, they would be long wave-length constructive waves. There would also be a large supply of shingle available beyond the low-water mark. H would then probably be a permanent ridge.

The supply of shingle for the formation of these ridges results from longshore drift by oblique wave action, and the greater this supply the stronger will be

the tendency to add new ridges. This relationship has been fully discussed by Johnson,* whilst Davis,† Gilbert,‡ Drew,§ and others offered suggestions concerning the building of these ridges, but in no case does the entire action seem to have been put forward.

Conditions affecting the direction of ridges.—When waves approach a curving shore-line, whether that of a ness or a bay, the breakers invariably reach a maximum development on the section which is parallel with them. This was repeatedly visible at Hurst and had been noted previously on many other parts of the south coast. Whenever a new ridge was observed being formed, it was invariably higher up the beach, by comparison with the other ridges, at points where the coast-line was parallel with the direction of the waves some distance offshore. From this it might be assumed that the highest ridges, that is, the most permanent ones, are always built by waves approaching directly onshore. This would cause the shingle ridges to take up a direction parallel with the main shore-line, which seems to be the normal action of the sea on a shingle foreshore.

Closer examination, however, seems to show that this control of the direction of a shore-line on the direction of the ridges is not absolute. The following examples are chosen to illustrate this point, that under certain conditions waves can build ridges in a direction independent of that of the shore-line.

Fig. 8 represents ridges which were observed being built towards the end of Hurst Castle Spit by oblique breakers. The waves were approaching the shore in the direction indicated. They were constructive in type and on nearing high-water mark were busily pushing forward shingle to the top of their swash slope, but their oblique direction prevented the formation of a continuous ridge. Instead, they were building a series of ridges AB, CD, leaving the last main ridge XY at angles up to 15°. The maximum distance which such ridges extended in front of XY was 2 to 3 feet, and then their direction changed together with a decrease in height until they tailed off indefinitely to join the main ridge. They were developed in the zone which was only reached by a weakened swash, and the little ridge was formed as soon as the power of this swash became too low to move its load obliquely forwards. On the seaward side they ended where the increasing power of the swash became sufficent to drive the material forwards again. Below these ridges normal oblique drift was very active along a smooth foreshore whose maximum slope was everywhere at right angles to the line XY. On beaches favourably disposed for oblique waves, these ridges have frequently been seen occurring at the high-water mark; the only reference to them seems to be one by Wilson.‖ The following quotation shows clearly that he recognized the connection between their direction and that of the waves which built them: "These serrations on the side of the spit seem to owe their origin to the attempt of the waves of a particular series of storms, coming from a nearly constant direction, to readjust

*D. W. Johnson, 'Shore Processes and Shoreline Development.'
†W. M. Davis, 'Outline of Cape Cod.'
‡G. K. Gilbert, "Lake Bonneville," *U.S. Geol. Surv. Mon.*, 1890.
§*Mem. Geol. Surv. of the Weald*, quoted by Topley.
‖ A. W. G. Wilson, "Cuspate Forelands at the Bay of Quinte," *Journ. of Geol.*, vol. xii, 1904

the curvature of the shore-line to the curvature of their own fronts." He also referred to the presence of deep water offshore enabling waves to break obliquely on the foreshore.

A small shingle foreland near Stone Point on the Solent presents an instance of ridges being formed in the direction of powerful waves, independently of the original coast-line, on a larger scale than the example just cited. The direction of the ridges is indicated in Fig. 9, AB being the direction of the main coast-line. An abundant supply of shingle from the south-west seems to be held up at this point by a stream too small to preserve a permanent outlet through the shingle. Large waves frequently come from the south-west and south; this is the direction of the prevailing winds and coincides with that of the greatest stretch of water up the Solent. The highest ridge P seems to have been built by waves approaching roughly onshore, but the section CD shows clearly the tendency to face south-west. The lesser ridges Q, R, S again show more clearly this tendency to face these oblique waves. A closer consideration of the features shown by the ridge EF might help in an explanation of its formation. The serrations between E and G are similar to those described at Hurst. The section GH presents a striking resemblance to these serrations on a larger scale, the ridge being well developed along GK and LM and decreasing considerably in height along KL and MH. Therefore it seems that the oblique waves which built it had gathered enough shingle, as a ridge at the top of the swash slope, to resist being pushed farther forward than the line GK by the weakening swash. As the ridge continued in the direction GK however, it extended farther down the foreshore, where the power of the swash would increase. The end of the ridge at K marks the point where the increasing power of the swash enabled it to drive the shingle forwards to the position LM. This tendency for ridges to leave the main shore-line at an angle more in accordance with that of oblique waves has been noted in numerous places where such waves are dominant and an abundant supply of shingle is present on the foreshore. Fig. 10 shows the disposition of ridges between groynes at Langney Point, near Eastbourne, an arrangement which was repeated between every pair of groynes along a mile of coast-line. The longest stretches of the front ridges BC, EF, always faced south, the direction from which large waves most frequently reach this coast. The presence of the groynes is an important factor in accounting for the outline of these little bays, but were they the only factor the curves ABC, DEF should be symmetrical, B and E being midway between the groynes.

An example on a large scale of shingle ridges being changed in direction by storm waves was provided on the mainland near Hurst Castle Spit. More than a quarter of a mile of beach, consisting of two or three large ridges, was turned through a considerable angle by a series of storms. AB (Fig. 11) represents the line of a low cliff, and CD, EF the present position of the ridges. At G a groyne which had been buried under the shingle recently came to light, whilst a newly built groyne at H was almost buried. This latter V-shaped groyne was built by the Milford Council to protect a building which was being endangered by rapid erosion of the cliff at this point. At that time, the shingle ridges must have been along the line XY, a large supply to bury the groyne and protect the cliff at G, and a meagre supply, which was easily combed down by storm

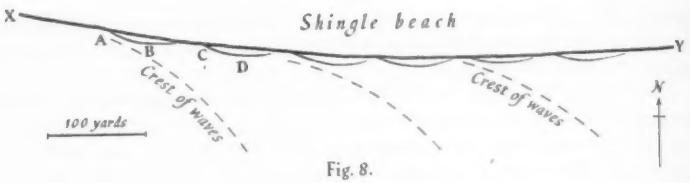


Fig. 8.

Fig. 9.

Fig. 10.

Fig. 11.

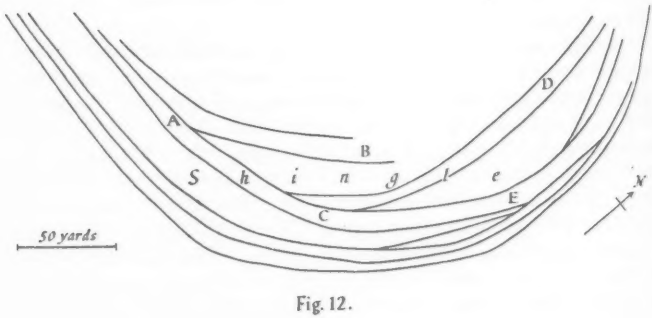


Fig. 12.

waves, allowing rapid erosion at H. The coastguard informed me that the shingle first started disappearing from G and that the ridges which buried the groyne at H appeared after a period of stormy weather in the November of 1929. At present very rapid erosion is proceeding in the neighbourhood of A.

The presence of the groyne at G, which had been buried for at least ten years, indicates that the shortage of shingle existing at this point to-day must have been repeated at some previous time. The groynes themselves are much too small to have affected such a widespread rearrangement of the shingle. This change in direction happened to be one in which the ridges turned so as more nearly to face the dominant south-west waves.

The more recent ridges on Hurst Castle Spit show that such a change, a swinging round so as to face the dominant waves, has taken place repeatedly at the end of the spit. Fig. 12 is from a plane table sketch made of the foreshore and ridges of Hurst Castle Spit.* The earliest ridges shown run in the direction AB and later ridges changed their direction to that of AC, showing the swinging round so as to be more nearly parallel with the main spit, this also resulted in a slight increase in the length of the spit. A similar change has taken place where the older ridges CD have newer ridges in front of them running in the direction CE. Such a change was repeated on a larger scale at other parts of the spit.

The above instances show that small oblique waves can build small ridges in the direction or their fronts, that larger ridges might be similarly built by large waves, and finally that storm waves can alter the direction of ridges in precisely the way that has taken place continually with the ridges forming Hurst Castle Spit. In accordance with such evidence, the way in which this spit first grew out from the mainland coast and the stages through which it has passed in reaching its present condition, will be suggested.

Formation of Hurst Castle Spit.—Hurst Castle Spit (Fig. 17), on leaving the mainland of Christchurch Bay, does not continue in the direction of this coast but turns so as to run north-west to south-east. After somewhat over a mile it changes to a west to east direction and then finally makes a sudden bend to run south-south-east to north-north-west. A considerable area of marshes has developed in the sheltered waters of the Solent to the lee of the spit, behind which the old cliff runs in a direction roughly south-west to north-east. Sand is frequently present on the south-west foreshore near the mainland, but the greater part of the spit seems to be composed entirely of shingle. A clay bench is exposed near high-water mark when storms remove sufficient material from the foreshore and, until the last few years, a part was still present between the spit and the marshes behind it. The largest waves come from the south-west, up the stretch of water between the Isle of Purbeck and the Needles; the prevalent waves also come from this direction. The only other considerable stretch of water is down the Solent from the north-east.

Let APB (Fig. 13) represent a coast-line which changes from its main direction AP to PB. Let oblique waves bring an abundant supply of shingle from A, and let large constructive and storm waves approach parallel with

*The writer wishes to express his thanks for permission to map these ridges, to E. T. Balne, Esq., Languard Road, Southampton, and to The Commander, Royal Engineers, Milldam Barracks, Portsmouth.

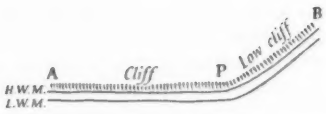


Fig. 13.

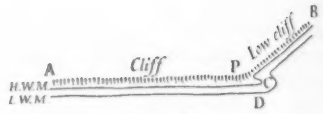


Fig. 14.

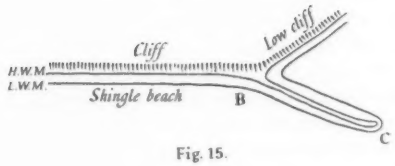


Fig. 15.

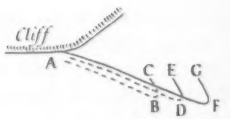


Fig. 16.

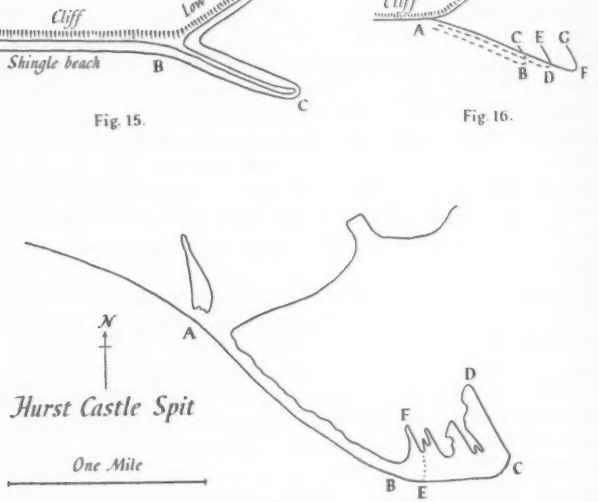


Fig. 17.

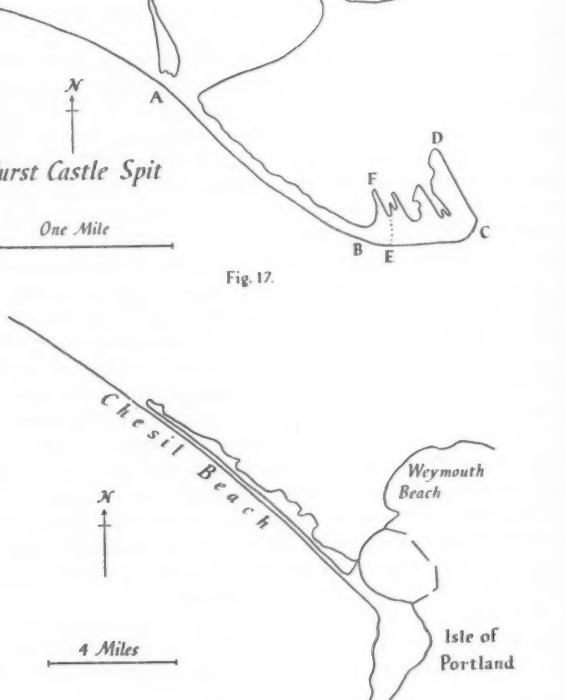


Fig. 18.

AP. As a result of down-combing waves an abundant supply of shingle collects below low-water mark (L.W.M. in figure) on the stretch AP. If large constructive waves parallel with AP accompany the next spring tides, this shingle will be swept up the foreshore to form a ridge ending at C, at high-water mark (Fig. 14). For shingle collected offshore from C would be driven up the beach till the weakening swash could no longer move its ever-increasing load forward, and this would tend to happen as soon as the line of the shingle ridge in front of the cliff AP was reached. This suggestion results from observations made at Hurst concerning the variation in the size of breakers as the coast-line changed in direction. On reaching a slight bend in the shore-line, the size of the breakers decreased considerably, though as the new direction continued they would gradually increase in size until another bend was reached when a similar reduction was repeated.

The ridge thus formed would be strengthened by the formation of lesser ridges in front of it under the action of constructive waves at ordinary and neap tides. Periodically, violent storm waves would cause important changes. The largest would approach the section AP directly onshore and comb down a considerable amount of shingle from the ridge at C and deposit it offshore beyond the low-water mark. In all probability they would overtop the young ridge, throwing much shingle behind C. It is important to note that they would not drive all the shingle from this point up towards B, but would drag the greater part down the foreshore. Later, the waves would again form a ridge, this time on a foundation broadened by the action of the storm waves.

Applying such reasoning to the case at Hurst, the clay bench would provide a foundation for the new ridge, thus aiding its extension from the line of the old cliff. On extending eastwards, however, it reaches the area protected from south-east waves by the Isle of Wight, with the result that the dominant waves come more from the south-west. The ridge then gradually assumes a direction parallel with these waves (Fig. 15).

Up to the present reference has chiefly been made to the factors which tend to prolong the spit, and as this action is suggested to be a periodic one, it is important to consider what is taking place at other times. This can readily be deduced from the action taking place at Hurst now that longitudinal extension has ceased. The normal direction of wave approach along the section AB (Fig. 17) was directly onshore, but from B to C it was oblique, due both to the change in the direction of the coast and the presence of deep water offshore. The shingle which drifted slowly from A to B was therefore hurried along from B to C. Returning to Fig. 15, it would seem that the shingle drifting from B to C under normal wave action, on reaching C would be hurried around the point, giving rise to an abundant supply just north of C. This shingle would then be driven up the foreshore to form a ridge by the next ridge-building waves to affect it, and as, in all probability, these would come down the Solent from the north-east, this lateral ridge would lie in the direction BC (Fig. 16). With a repetition of ridge-building waves from the south-west the spit might be extended to D and later recurved to E, and finally to F and G. The retreat of the main spit from AB to AF is probably in accordance with the retreat of the main shore-line by normal erosion, and is accomplished by the action of great storms in sweeping shingle from the front of the ridge

over the top, an action frequently described in connection with such shingle ridges,* together with the consequent erosion of the clay bench. Some of the early recurves are still present at Hurst, but there is a profusion of later ones, and their marked parallelism, facing directly up the Solent, is most striking. As the spit gets prolonged beyond F it assumes more closely its present stage, and therefore the conditions affecting its growth must resemble more and more closely those obtaining at the end of the spit to-day (Fig. 17). After a study of these conditions at B the following conclusions were reached concerning the non-extension of the main spit beyond this point.

The conditions necessary for a prolongation of the spit beyond B are: an abundant supply of shingle on the foreshore at B and ridge-building waves, preferably during spring tides. That these waves will occur under our variable weather conditions can safely be assumed, but the doubtful factor is the presence of sufficient material within reach of the waves at the critical time. As the spit extends into deeper water, there are two factors which militate against the presence of this shingle, the greater slope of the foreshore beyond low-water mark and the more oblique waves which result from the increased depth of water offshore. The greater slope referred to reduces the area from which constructive waves can collect material to build into ridges. The greater frequency of oblique waves would cause material to be swept quickly past this point B to the foreshore in front of EF, leaving a paucity at B. Thus, the material thrown up by large south-west waves would not form a ridge at B massive enough to resist the forward drive of these waves, but would be carried round to the EF foreshore.

It now remains to suggest reasons for the extension of the spit from B to C. Fortunately this point is simplified by the fact that an addition of shingle is still taking place at C, that is, the spit is still extending slowly in the direction BC. The reason seems to be the change in the rate of drift from B to D, at C. The waves which cause such rapid drift from B to C, in order to reach the stretch CD have to turn through nearly 180°, and in doing so become considerably reduced in size. When waves were over 6 feet high on breaking along AB, those reaching CD varied between 6 inches and a foot in height. Thus the travel of material from C to D is very slow. This results in an abundant supply of shingle being present on the foreshore east of C, to be built into ridges by the next effective ridge-building waves to occur. Those from the south-west would be too powerful for the reason already stated, and it seems that this would be the case with all waves from a direction west of south. Those from the south, however, limited in size by the available stretch of water, would find sufficient shingle present to form a ridge massive enough to resist their forward drive. These would therefore be the effective ridge-building waves for this stretch and the ridge would be extended in the direction BC.

The numerous recurves from EF to CD result from the conditions already referred to, so well shown in the prolongation of CD at present, namely, a slow but continuous supply of shingle and comparatively frequent down-Solent, ridge-building waves.

The sharpness of the point at C then, seems due to the sudden change in

*D. W. Johnson, 'Shore Processes and Shore-line Development'; Carey and Oliver, Tidal Lands'; J. A. Steers, "Orfordness," *Proc. Geol. Ass.*, vol. xxxvii. 1926.

aspect caused by the proximity of the Isle of Wight coast. Thus the shingle on the foreshore at C comes under the influence of only two sets of ridge-building waves, which are inclined to each other at more than 90°, the south waves across the stretch of water from the neighbourhood of the Needles and the north-east waves down the Solent (Fig. 19). The smooth curve of Calshot Spit, where there is no sudden change of aspect, presents a striking contrast. This sudden bend at Hurst invites comparison with similar features in other parts of the coast, especially Dungeness. The sharpness of the point at Dungeness again seems as if it might be due to the sudden change in aspect; that is, large waves approach either from the south or from the east, but very rarely, owing to the narrow stretch of water, from the south-east.

As most writers on Hurst Castle Spit have explained the halt in its growth by the strengthening of the tidal currents as the channel became more confined, I took a number of observations in order to ascertain the part played by these currents. The race off the point C (Fig. 17) on the ebb tide is very swift, a surface velocity of from 4 or 5 knots within a few yards of the shore. The effect on the shingle of a change in intensity and direction of these currents was entirely different from what had been anticipated. When the waves were very small the current was unable to move even the lightest shelly material, the inference being that the velocity decreased considerably as the bottom was approached. With large waves coming up the Channel from the south-west and the tidal current in the same direction, the breakers at the point were surprisingly small. When the current changed in direction it became much swifter and hugged the foreshore, and at the same time the size and obliquity of these south-west waves was greatly increased. The waves were so oblique that only the parts in contact with the shore were breaking, and this resulted in a series of swashes sweeping along the shore and giving rise to a rapid drift of the shingle.

On several subsequent occasions the same phenomenon was noted, the powerful ebb current increasing the size and obliquity of the waves travelling in the opposite direction, thus increasing the drift of shingle in this direction. It is instructive to note that at the point C, where the tidal current is the most powerful immediately offshore, the spit is still extending slowly out into the Solent. This instance therefore seems to suggest that tidal currents have little or no effect on the prevention of the growth of a shingle spit.

The Chesil Beach.—The neighbourhood of the Chesil Beach (Fig. 18) is the finest example in the British Isles of a coast facing the direction of the dominant waves. This feature, so striking in its grandeur, has given rise to a copious literature, some of the more important contributions being due to Coode,* Lyell,† Strahan,‡ Prestwich,§ Cornish,‖ and Baden-Powell.¶ These writers, however, were more concerned with the source and grading of the shingle composing the beach than with its actual formation.

*"Description of the Chesil Bank," *Mins. Proc. Inst. Civ. Eng.*, vol. xii, 1852–3.
†'Principles,' 10th ed., vol. i.
‡"Geology of Isle of Purbeck and Weymouth," *Mem. Geol. Surv.*
§"Origin of Chesil Beach," *Mins. Proc. Inst. Civ. Eng.*, vol. xi, 1875.
‖"On the Chesil Beach," *Geogr. Journ.*, vol. xi, June 1898.
¶"On the Geological Evolution of the Chesil Beach," *Geol. Mag.*, 1930.

If the clay bench detected in places by Coode, underlying the landward side of the bank at about low-water level, extends right to Portland, it seems probable that the whole beach was first formed in front of a cliff, a stage shown at present by its continuation to the north-west. With the erosion of the cliff behind, the bank retreated until the land separating it from the drowned valley of the Fleet was entirely removed and it took up its present position. On the other hand, if Portland was once an island, the bank probably grew out from the mainland, passing through the stages described in the growth of Hurst Castle Spit. Rapid extension to the south-east with an abundant supply of shingle would be helped by the protection of the Isle of Portland from south-east waves, for these would tend to build long recurves into Weymouth Bay to the detriment of longitudinal extension of the main spit. The observations

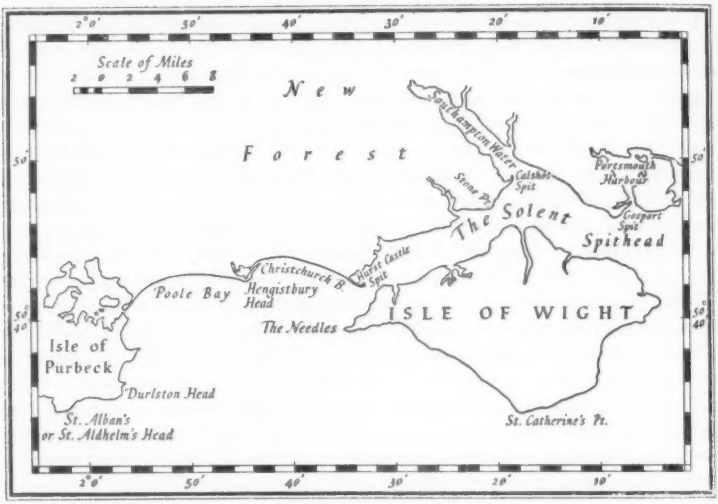


Fig. 19

of the effect of the tidal race at Hurst Castle Spit suggest that such a race between Portland and the mainland would not interfere with the continued extension of the spit.

By whichever method it was built it has in the meantime swung round so as to face the dominant storm waves. This process might still be taking place at present, for, taking the highest ridge formed in 1852 as the standard, there were at the time of observation eight ridges in front of it at the Chesilton* end, whilst about 2 miles to the north-west there were only five. An important feature with the Chesil Beach is that the direction of approach of the dominant waves coincides with that of the prevalent ones, so that in facing the dominant waves the bank has taken up a position which prevents any permanent drift in either direction. The agreement between a line perpendicular to the beach

*Situated where the bank joins the Isle of Portland.

and the mean of the wind from anemometer observations* is so close that Coode and Prestwich, by slight differences of interpretation of the same results, deduced drifts in opposite directions. It seems that the mean aggregate wind direction is only one of several factors determining the direction of drift on a coast-line, it is important on open coasts but on confined ones the length of fetch seems to play the dominating part. In both cases the large and small swell waves coming from the nearest stretch of open water must be very important, acting as they do in a constant direction independently of the winds.

This absence of any permanent drift at Chesil would result in material added from the west or east being uniformly distributed along the foreshore. It would then be piled up by ridge-making waves at spring tides into minor ridges which would remain until some great storm drove a portion of the material up the beach to form a higher, more permanent ridge. A continuation of this process would result in the highest ridge representing the work of the last great storm which did not completely overtop the bank; the long slope behind the ridge is due to storms which overtopped the bank sweeping the shingle considerable distances inland. These views are in close accord with those early expressed by De la Beche† and Lyell and are supported by evidence due to Coode, who gives a diagram of the profile after the great storm of 1852 showing clearly that the highest ridge of to-day was built by that storm. The importance of these great storm waves in shaping the bank was emphasized by the remarkable way in which a slight salient in the highest ridge, about 2 miles north-west of Chesilton, was repeated in the six ridges down to the present foreshore, whilst elsewhere lesser indentations were repeated in two or three of the neighbouring ridges. This slight irregularity, the result of a storm of over eighty years ago, still remaining in the foreshore, does convey some idea of the permanency of the changes wrought by such storms.

The Chesil Beach, then, presents an example on the grandest scale of the suggestions put forward in this paper, that in certain circumstances waves play the important part in determining the direction of the ridges which they build.

DISCUSSION

Before the paper the President (Admiral Sir WILLIAM GOODENOUGH) said: Mr. Lewis, who is to lecture to us this afternoon, has, as you can see, no past history, the reason being that he has not lived quite long enough to have one. He took his degree about two years ago in the Geographical Tripos, since when he has been Assistant Demonstrator in the Department of Geography at Cambridge. After a visit to Scolt Head with Mr. Steers it occurred to Mr. Lewis that there were certain questions that wanted further examination, and so he spent his vacation in studying the coast. The paper that you will hear this afternoon is the first instalment of his conclusions, put forward as suggestions for discussion. I now call upon Mr. Lewis

Mr. Lewis then read the paper printed above, and a discussion followed.

Mr. J. A. STEERS: I have but little to say which bears directly on the subject of the paper. Whilst having great interest in coastal studies I have not worked, to any extent, on the effect of wave incidence on the profile and form of beaches.

*'Report Brit. Assoc.,' 1844, p. 241.
†*The Geological Observer.*

There are however certain points raised by Mr. Lewis about which I should like further information. One of the more interesting points suggested in the paper was that shingle bars leave the mainland at a slight angle. If I remember aright the explanation given for this seemed to depend partly on the direction from which the prevalent or dominant waves come. I am more familiar with the east coast than with the south, and particularly with the north Norfolk coast. There you have Scolt Head Island and Blakeney Point, two shingle and sand bars running to the west, or slightly to the north of west. I take it that Mr. Lewis's explanation would be that they are partly due to dominant waves coming from between north and east?

Mr. LEWIS: That is so.

Mr. STEERS: That is what I assumed, and although I think there is probably a good deal in it, I believe other factors must be considered. For example, as you go westward along both those bars, but more especially at Blakeney, you get to shallower water, and find a greater expanse of sand beaches, sand banks, and so on. I do not claim that the sands are the sole cause of the banks leaving the mainland at an angle, yet I feel that they must be considered to some extent as a factor governing the direction in which the main bars run. At the Headland (Blakeney) the direction of the beach changes from one slightly to the north of west to one south of west. Scolt Head Island shows a similar change of direction at Scolt Head proper. These changes in direction may be due to waves coming from the north-west or north-north-west, but it cannot be said to be proved that it is so. More information is required on this matter.

Another interesting point concerns the coast between Sheringham and Blakeney. I believe I am right in saying that the drift of shingle at Sheringham is, for the most part, to the east.* At any rate I think it is true that the shingle is piled up on the west of the groynes at Sheringham and to a little to the west of that town, and that this is definitely the case farther east. The shingle, on the whole, decreases in amount eastwards of Sheringham. But from Sheringham to the end of Blakeney Point is a smooth, unbroken line of shingle, and Blakeney Point is undoubtedly growing to the west, whereas at Sheringham there would appear to be an easterly movement, though not necessarily at all times. I am told that opinion at Sheringham seems to suggest (I stand to be corrected here) that this east-directed movement is due largely to winds and storms blowing from between north and west. If, then, there is a westerly movement of beach material at Blakeney, and an eastward movement at Sheringham, and east of that town, I am not clear how the arguments raised in this evening's lecture elucidate the matter. Somewhere along a comparatively straight stretch of shore the shingle movement appears to alter. How or why this is so is not clear.

Again, on the Suffolk coast, the northern beach (Sudborne Beach, *i.e.* that part between Aldeburgh and Orford Lighthouse) of Orford Ness is certainly built out from the mainland, but only in the sense that the trend of the old coast alters south of Aldeburgh from approximately a north-south line, to one west of south. Sudborne Beach however continues the general southerly trend. I am not clear if the suggestions put forward by Mr. Lewis for the directions assumed by shingle bars can apply in this case.† It is certainly different from Blakeney Point, which turns definitely outwards from the trend of the coast.

*'Royal Commission on Coast Erosion,' vol. i, pt. 1, 1907. First Report. Minutes of Evidence, 2517–2520 (C. Reid), 2672 (C. Reid), 4148 (W. H. Wheeler); and information in a letter from the Borough Surveyor at Sheringham, 1931.

†Since the meeting I have visited Orford with Mr. Lewis, and we noticed that near the Lighthouse Sudborne Beach did turn very slightly eastward. Nevertheless the general trend of that beach was nearly north-south.

Mr. Lewis referred to constructive and destructive waves. The difference between them seems to be partly due to the water motion in the waves. It would be interesting to have further details on this matter and, if possible, some means of differentiating clearly between them, since they would appear to grade almost imperceptibly one into the other.

Mr. Lewis has approached the problems he has in mind in an interesting way, though for the most part theoretically, and is to be congratulated on his originality. I hope he will apply his reasoning to various parts of our coast, and test how far his theories apply to the actual facts. It has always seemed to me that shingle bars and forelands, etc., need individual study. Generalizations, although often highly suggestive, do not necessarily apply to every case.

Dr. DIGHTON THOMAS (Natural History Museum): I am afraid I really have not much to say on this problem, and any remarks I have to make come from me rather as a geologist. I am very glad Mr. Lewis has taken up this matter of wave action and given us his theories. Palmer and Lyell and Sir John Coode showed long ago that transport by waves is quite an important factor in geomorphological and geological phenomena, but I think there has been in the past rather a tendency to disparage the part played by waves in favour of that played by currents and tides. Perhaps we have done that because we can see waves but not currents, and there is often at the back of our minds a tendency to explain things by reference to what we do not know sufficient about rather than by the actual things we can really see. Thus, as round our coasts very often the tides and the currents are actually operating in the direction of the dominant waves, and knowing that currents and tides do exert great forces, we have ascribed the major results to the force of the currents. But we cannot always fit the results which we see to the tidal current action. For example, at Blakeney Point, as Mr. Steers has pointed out, shingle is growing to the westward, *i.e.* against the tidal direction, and it seems obvious there that the shingle accretion and the growth of the Point is, over a large part at any rate, due to wave action. In a paper before the Society Mr. Steers mentioned the fact that waves can move shingle in the direction opposed to that of the tidal drift, and a similar observation has been recorded by Mr. Marsh at Orford Ness. Mr. Lewis has shown now that wave incidence has played, as he thinks (and I am inclined to agree with him) an important part in determining the direction of the ridges that the waves build. After all, the actual edge of the shingle shore comes under the action very much of the waves, and perhaps more so than that of currents; at any rate, the current immediately off-shore, or against the shore, is very much reduced by friction of the water itself and also by the movement of the waves. The energy of a breaking wave is, after all, quite a respectable amount. The initial velocity of the swash of even an ordinary wave is fairly great, and you must remember that its load is proportional to the sixth power of that velocity. We may thus obtain some idea why waves are potent factors both in constructive and destructive work. We should therefore not be surprised if we see that it is really the waves which determine the direction of shingle ridges.

There are one or two questions I am not happy about. Mr. Lewis in one of his diagrams showed a series of small ridges coming off at angles with the main ridges. I would suggest to Mr. Lewis that perhaps these smaller ridges are not really the permanent ones, and that generally the permanent ridges are built up parallel to one another and parallel to the actual breaker edge by, of course, big storm actions, and that these smaller ridges tend to be removed by the beach-combing waves. For example, on the Crumbles you can see a whole series of some sixty or seventy shingle ridges parallel to one another and parallel to the line of breakers. I rather think that one would expect the actual ridges to be

parallel to the line of the breakers, even with oblique waves. Although the waves may be oblique to the shore, the actual break, of course, takes place at the points of shallowing, which lie along a line parallel to the shore-line. Thus, in spite of the wave approaching obliquely, the actual breaking surface comes parallel to the shore, and therefore the ridge should be parallel too.

I am afraid I do not know the Hurst Castle Spit, but Mr. Lewis suggests that the recurved end is due to north-east dominant waves caused, I presume, by winds coming from that direction. After all, do we need them? Why not the south-west waves coming up and breaking on the spit, and then, simply from the fact of their piling up, the waves spin round, as it were, at the tip of the spit, and approach from the north-east?

Then with regard to the turning of the spit, and the desire of the shingle ridges to face south as, Mr. Lewis says, the predominant waves come from that direction—I am not sure that perhaps he is not missing out something which is due to currents. After all, with this building out of the shingle spit the current, I feel, must be somehow affected, and, at any rate, deposition of sand, mud, and so forth, by currents, will be taking place just off the end of the spit. It is possible that the turning may be due to building up of the shingle on sand or mud laid down by currents, rather than to the wind coming from the south instead of the south-west. That is, that with the waves coming from the south-west and the spit growing to the south-east, current action is going on, maybe of conflicting currents. Deposition may have occurred in one place, and the actual turn in direction of the spit may be due to the fact that the shingle has been deposited on that accumulation, which is due to conflicting currents; at any rate, it would appear that the currents then would govern the direction of the spit, rather than that the direction of the waves would account for its turning.

I would like to congratulate Mr. Lewis very much on his excellent paper and the great amount of food for thought which he has given us.

Professor DEBENHAM: This is not a subject on which I feel very competent either to comment or criticize. There are however one or two points that occur to one immediately on hearing such a new orientation of a very old subject as Mr. Lewis has given us. I thought, for instance, that his point about the frequency of the wave giving either a combing action or a building action was very well taken. I cannot say I feel quite happy about his mechanical explanation of it: that the momentum of the short-frequency waves was lost or rather was expended in the vertical direction, and that of the long-frequency was more horizontal. I think that is open to other explanations. I do not think it has been made a sufficiently strong point in that connection that the frequency of the waves may have diametrically different actions on the material. It is not a question of frequency alone. The action depends on the depth of the water and the rate at which the wind happens to shift the surface water, so one cannot say it is purely a function of frequency. It will depend, again, on the gradient of the beach, which affects the rate of the backwash, as Mr. Lewis has said.

I was interested to hear how Mr. Lewis interpreted certain forms from the angle of incidence of the waves. I think the whole theory must be applied more in detail to other places before one is quite satisfied with it. It seems to explain Hurst Castle Spit very well except in one or two points. I also feel rather unhappy as to his explanation of why the spit changed direction; the reason given seemed to be opposing the general theory without adequate grounds. Perhaps Mr. Lewis may find a different explanation for those minor points. We know about the lateral shift of material by the waves, but actual direction of the spit, it seems from Mr. Lewis's account, should be controlled by the direction of the dominant waves. So there one gets into deep water in two senses.

If Mr. Lewis's explanation of the visible ridges above tidal mark is correct you should get something of the same thing happening in such ridges as are formed by wave action under water and hardly appear above sea-level. Just before the lecture I asked Mr. Steers what direction were the ridges or rolls of sand at Scolt Head which are just exposed at low tide and are therefore really under-water features, and he said, to my gratification, that they, too, run at a slight angle to the coast. Therefore in the case of Scolt Head you have first an original coast; outside that you have shingle spits above water at a slight angle to the original coast, and, farther out, under-water features, ridges of sand set at still further obliquity to the others; so that whatever the process may be it is happening under water as well as above. That increases my feeling—perhaps not yet a conviction—that Mr. Lewis is on the right lines. I certainly hope he will go ahead with further applications and will modify perhaps a few of the minor explanations, which do not however affect the main theory which he has given us. I would like to add my congratulations to Mr. Lewis on his able exposition of his theory.

The PRESIDENT: I call on Mr. Lewis to answer the few questions which have been put to him and perhaps at the same time he would be so kind as to answer a question which may appear to come from one who is terribly ignorant. What I want to ask is if it is known how deep is the shingle on Chesil Beach.

Mr. LEWIS: I do not know.*

The PRESIDENT: That shows the great advantage of having a question asked by some one who really knows nothing about the subject.

Dr. THOMAS: I think Mr. Lewis should be able to answer that from the part of the paper which he did not read. He states that in some places in Chesil Beach it is possible to see mud, very probably the old shore line. I think that would mark the base of the shingle.

Mr. LEWIS: Both Mr. Steers and Dr. Thomas suggested that the deposition of sand or mud by wave or current action might account, at least in part, for the direction of shingle ridges. The real motive for my selecting Hurst Castle Spit for more detailed field work, in preference to Blakeney Point or numerous other spits, was that there is no deposit of sand or mud near the end of the spit. Thus it does seem that, in this case at least, one can attribute the shaping of the spit to wave action. With regard to the second point which Mr. Steers brought up, I am sorry I did not make myself clear. There need be no definite connection between the direction of the prevalent waves which cause the drift of shingle along a coast-line and the dominant, or larger storm, waves which I have suggested influence the direction of ridge building.

Dr. Thomas suggested that the south-west waves might build the lateral ridges at Hurst. From observation, these waves, after curving round the end of the spit, have become so reduced in size that they appear quite inadequate to pile the shingle into ridges of such a height. The straightness of these ridges and their uniform height throughout their whole length also suggest strongly that the north-east, not the south-west, waves are responsible for their building.

Professor Debenham suggested that the surface drift of water and the beach gradient must also be considered in addition to wave frequency, in accounting for the destructive or constructive action of waves. I am grateful for having attention drawn to these factors which I had not stressed sufficiently, for it was my intention to indicate wave frequency, or rather wave length, as the dominant and not the only factor to be considered in this connection.

Finally, I should like to express my sincere thanks first to Professor Debenham for enabling me to carry out these researches and for the continual encourage-

*The depth will be found in Sir John Coode's "Description of the Chesil Bank." *Mins. Proc. Inst. Civ. Eng.*, vol. xii, 1852–3.

ment he has given me; secondly to Mr. Steers for drawing my attention to the subject and for his readiness on all occasions to help me with the more technical problems; and also to Mr. Lake for his most valuable suggestions concerning the arrangement of this paper.

The PRESIDENT: These scientific investigations bring out matters of very great interest. As I first read the paper by Mr. Lewis and then listened to his lecture I tried somehow to make the connection between the scientific investigation and the practical application. Please do not assume that I am one of those who believe that the only use in scientific research is that of material advantage. Far from it. Nevertheless, one must think of it, and I may say that my own profession and the fact that we are a maritime nation makes one think of the building of harbours. I call to mind two instances which are of very great interest though neither is in connection with harbours in this country. One is the harbour of Sekondi on the Gold Coast. It was desired to make the harbour there to tap the whole of the Gold Coast and down from Kumasi. They made piers and breakwaters, but do what they would they could not keep the silt out. It was mostly sand, and it was a question of current there, not waves; the Guinea current washed the sand in, and after something like a million pounds had been spent it was decided that it would be necessary to move the harbour 5 miles to the westward and the great harbour of Takoradi, which I have no doubt you all know something about, was constructed.

The second instance is one which I have been trying all day to identify because I feel it would be even more interesting than the first. It happened in New Zealand, where there is a harbour that I cannot at the moment name, where, after the contractor had made his contract and put his groynes in, the nature of the waves and currents so assisted him that it is said he sat on a veranda with a pipe in his mouth and watched his fortune being made by the sea. I should be glad if some of you younger men would say whether I dreamed that or whether there is such a harbour. I believe if you search about sufficiently you will find it somewhere. So far I have failed. If I dreamed it, well then it was a very good dream. [Later note by PRESIDENT.—The harbour is that of Timaru.]

Not only, Mr. Lewis, may I congratulate you on behalf of the Society on the great interest of your lecture, but I should also like to congratulate you, if I may, on the lucidity with which you have explained a subject that I do not suppose very many of us know much about. You have made it quite clear. You have not used jargon; you have used plain speech that we can all understand, and I for one am deeply grateful to anybody who approaches a scientific subject in that manner.

You reminded us of the roar and noise of shingle beaches, Chesil Beach in particular. Many can imagine, and it is very familiar to me, the roar which first of all you cannot sleep for and then you cannot sleep without. With that I would offer you, on behalf of the Society, our best thanks. I wish that more members attended these very interesting afternoon lectures. You have told us much of interest and much that is useful as to wave incidence. Thank you very much.

ISLAND ARCS AND MOUNTAIN BUILDING: *A paper read at the Afternoon Meeting of the Society on 13 April 1931, by*

PHILIP LAKE

IN the first volume of 'Das Antlitz der Erde' Suess shows that the part of the Earth's crust which is bordered on the north and north-east by the Carpathian arc has been thrust over the foreland. The Carpathians are formed of Cretaceous and Tertiary beds thrown into folds which run parallel to the direction of the range. The foreland includes rocks ranging in age from Archaean to Tertiary and the structure is independent of that of the Carpathians. In general the boundaries between the different formations in the foreland run almost at right angles against the Carpathian border and are there abruptly cut off. The formations cannot suddenly cease to exist at this border, the boundary-lines between them must continue, and there is nowhere for them to continue except beneath the Carpathians. It is in Silesia that the evidence is most striking. Here the Carpathian border cuts across a broad Carboniferous basin, and the southern rim of the basin must lie beneath the range. Hochstetter, Stur, and Jicinsky had already recognized the probable continuance of the coal in this direction; and Suess follows Jicinsky in representing the coal-seams as forming the northern half of a basin of which the southern half must be beneath the Carpathians. More recent work has shown that the structure is not so simple as this, but the general conclusion remains unchanged, and borings within the Carpathian border have shown that the coal continues beneath the range.

The Carpathians however are not old and still retain too much of their original height to encourage exploitation beneath them. The coal-field of Belgium and the north of France has been similarly over-ridden by a mountain range, but it is an ancient one and has been so far worn down that it is possible to work the coal below. Here, accordingly, the relations of a mountain-range to its foreland have been determined with a completeness and precision unequalled elsewhere except in the North-West Highlands of Scotland. The over-riding mass has moved northwards upon a thrustplane. In sliding forwards it has itself been folded, and along the southern margin of the coalfield the underlying beds have been so much disturbed that a vertical shaft may pass through the same coal-seam four or five times in succession. At some later date there was a certain sagging along the axis of the coalfield and the thrustplane was bent into an anticline and syncline; and subsequent denudation has left outlying patches of the over-riding mass resting upon the coal basin. Incidentally it may be noted that similar outlying patches of Carboniferous Limestone rest upon the Coal Measures at Vobster and Luckington, north of the Mendips.

In the North-West Highlands of Scotland the base of a still older mountain range is exposed to view. There are no shafts or borings here, but the valleys have been cut so deep that actual sections of the base are visible on the hillsides. Again we see a part of the Earth's crust pushed over the foreland upon a thrustplane. The movement has in this case been towards the west and the intensity of the disturbances was greater than in Belgium. Successive slices of the fore-

land were involved in the movement, and instead of a single thrustplane there are four or five, one beneath another. The thrustplanes, as in Belgium, have been slightly deformed by later movements, and at one locality have been thrown into a sharp fold.

These examples are enough to show that some mountain ranges have been formed by a part of the Earth's crust being pushed over the part in front of it upon a thrustplane, the over-riding and over-ridden parts both being folded or faulted in the process. The mountain range which appears upon the surface is the edge of the over-riding part thickened by the folding and faulting which accompanied the movement up the thrustplane. As Suess has expressed it, such a range is the crumpled edge of a scale of the Earth's crust which has been pushed over its foreland.

If the thrustplane is a true plane the mountain range must have the form of a circular arc, for the outcrop of any plane which cuts into a sphere is an arc of a circle. In 1903 Professor Sollas* showed that many mountain and island arcs are truly circular, so far as a large-sized globe will show, but he had no explanation to offer. We cannot infer from the shape that there must be a thrustplane at the base of each, but we can say with confidence that a thrustplane at the base would account for the shape and that no other explanation is so simple and complete.

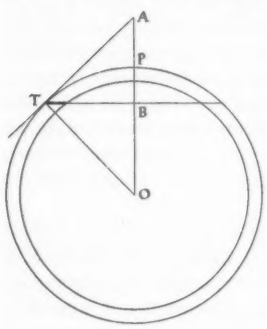


Fig. 1

Moreover, if there is a thrustplane at the base, it is easy from the form of the arc to determine the dip of that thrustplane at its outcrop, for the angle which the thrustplane makes with the surface is equal to the angle subtended at the centre of the Earth by the radius of the arc. (Fig. 1: The thickened portion of the line BT represents a thrustplane cutting through the outer crust of the earth. P is the pole of the arc made by the outcrop of the thrustplane. The angle ATB, made by the thrustplane with the surface, is equal to the angle AOT subtended at the centre by the radius of the arc.) All that is necessary is to determine the pole of the arc and measure the radius in degrees and minutes of a great circle.†

If the mountain arc is not circular a negative inference is possible. There is not now a plane thrust-surface at its base. It is possible however that the range was formed upon a true thrustplane and that there has been subsequent deformation. Or the surface along which movement took place may not have been a plane, or the movement may have been of a different character altogether, for there are other ways in which a mountain-range may be formed.

For the present however we are concerned only with mountain and island arcs which are so nearly circular that little or no deviation from the circular form is perceptible upon a large globe. One of these is the Himalayan arc, the pole of which is placed by Professor Sollas at 42° N., 90° E.

Quart. Journ. Geol. Soc., vol. lix, p. 180.
†Lake, *Geol. Mag.*, 1903, p. 305.

Everywhere along the Himalayas, a distance of some 1500 miles, there runs a great fault, which generally lies between the Siwalik beds of the foothills and the Pre-Siwalik rocks which constitute the main part of the range. The existence of this fault, which is called the main boundary fault, has been known from the early days of the Indian Geological Survey; but it was the work of Middlemiss* in Kumaun and Gahrwal which first cleared up the structure and revealed the history of the movements. In this area there are several thrusts, all leaning to the south, and the mountain mass was pushed up these thrusts from north to south. The northernmost of the thrustplanes is the oldest, and the others followed in order from north to south. Thus successive slices of the foreland were involved in the movement as in the North-West Highlands.

The fact that the boundary fault is continuous throughout the length of the range suggests that it is the basal plane upon which the mass as a whole has moved. The radius of the Himalayan arc is about 14°, and if the arc is determined by a thrustplane at its base the dip of the thrustplane must be about 14°. In Middlemiss's sections, and in all previous ones, the thrusts are represented as dipping at a high angle, resembling in this respect the minor thrusts of the North-West Highlands rather than the major thrustplanes of that region. More recently however in Jammu Province, where contoured maps were available, Middlemiss† found by measurement that the dip of the boundary fault is 12° to 15°. Moreover, from his experience there, he thinks that previous estimates have been much too high. The topographical maps employed were on too small a scale and were without contours, so that it was impossible to do more than guess the amount of the dip.

The close agreement of the only accurate measurements of the dip of the boundary fault with the amount deduced from the form of the arc can hardly be an accidental coincidence, and it seems reasonably certain that the Himalayan arc owes its shape to the fact that it is the edge of a mass which has been pushed southwards upon a great thrustplane dipping northwards at an angle of about 14°. Middlemiss's observations show that successive slices of the foreland are being involved in the movement, but it is not yet clear how far this is due to the subsidiary folding and faulting which takes place beneath the over-riding mass and how far to the formation of other major thrustplanes beneath the boundary fault.

Many of the island arcs which lie off the east coast of Asia are also circular in form. They are the tops of mountain ranges rising from the floor of the sea, and it is reasonable to suppose that, like the Himalayas, they owe their shape to the fact that they rest upon thrustplanes. The Aleutian arc is the finest example of all. The East Indian arc is almost as good till it reaches the hook round the Banda Sea; but it is more complex, its transverse width is greater, and there cannot be the same precision in determining its pole from topographical considerations alone. Professor Sollas places the pole at 15° N., 118° E.

Professor Sollas points out that the poles of several of his circular arcs lie upon the same great circle. If these arcs are the outcrops of thrustplanes it follows at once that the thrustplanes are all at right angles to the plane of the great circle that passes through their poles.

*_Mem. Geol. Surv. India_, vol. xxiv, pt. 2.
†_Rec. Geol. Surv. India_, vol. I, p. 122.

I will not here discuss Professor Sollas's great circles. His circular arcs are not all mountain arcs, and it is only with these that we are concerned at present. But a comparatively cursory inspection of a globe shows that the poles of the Asiatic island arcs (excluding the Aleutian arc, which belongs rather to America) must lie somewhere near a great circle, and they deserve closer examination.

Professor Sollas found the poles of his arcs by trial with a pair of compasses upon a large globe, but this method is satisfactory only when the arc is linear and extends through a considerable part of the circle. When the arc is short a more exact method of determining the pole is required, and when the arc is a belt rather than a line a more precise definition of the arc is necessary.

The Kurile arc is entirely volcanic and is linear enough without further definition. (Fig. 2: The centres of the small circles are points upon a circular arc with its pole at 55° 23′ N., 135° 47′ E., and a radius of 13° 2′.) In the Japan arc the most significant geological line is the great fault or thrust running along the longitudinal valley, and accordingly this line has been taken as representing the arc. The Riu Kiu arc is divided by Richthofen* into three zones —Volcanic, Palaeozoic, and Tertiary; I have taken the outer edge of the Tertiary zone as defining the arc. In the Philippines the most complete of W. D. Smith and Maso's† tectonic lines has been selected. (Fig. 3: The thick line, interrupted over the sea, is the most continuous of the tectonic lines of W. D. Smith and Maso. The centres of the small circles are points upon a circular arc with its pole at 5° 13′ N., 115° 55′ E., and a radius of 10° 23′.)

Fig. 2. Kurile Arc

Having chosen these lines as representing the arcs the next step was to determine on the largest-scale map available in Stieler's Hand-atlas or the *Times* Atlas the latitudes and longitudes of three points upon each line, one at each end and one in the middle. From these data the position of the pole of a circle passing through the three points was computed. The positions of the poles are shown upon the map, and in each case a circular arc—circular upon the sphere, not circular upon the map—has been drawn through the three selected points.

The positions of the poles and the radii of the circles are shown in the

Sitz. d. k. preuss. Akad. d. Wissensch., 1902, pl. III.

†*Philippine Journ. Sci.*, vol. viii, sect. A, No. 4, 1913, pl. II. These lines are reproduced in the map given in the French edition of 'Das Antlitz der Erde,' vol. iii, p. 1395.

following list,* to which has been added the position of the pole of the East Indian arc as determined by Professor Sollas:

	Pole		Radius
	N. Lat.	E. Long.	
Kurile Arc	55° 23′	135° 47′	13° 2′
Japan Arc	40° 16′	133° 4′	6° 26′
Riu Kiu Arc	32° 9′	121° 19′	8° 25′
Philippine Arc	5° 13′	115° 55′	10° 23′
East Indian Arc	15° 0′	118° 0′	—

How far these circular arcs correspond with actual features may be judged to some extent upon the map, or on a globe; but to illustrate more clearly the degree of correspondence larger-scale maps of the Kuriles and the Philippines are provided in Figs. 2 and 3. In these maps several computed points belonging to the circular arc are indicated, including those used for the determination of the pole. In both cases it will be clear that the correspondence is close, and it is equally good in the Riu Kiu arc.

The Japanese arc† is not a good circular arc, either topographically or geologically. There is, in fact, an elbow about Tokyo, where the Shichito volcanic line enters the main island and the Fossa magna of Naumann crosses and disturbs the tectonic lines. Appearances suggest a disturbed circular arc, and no clearly defined position can be assigned to the pole.

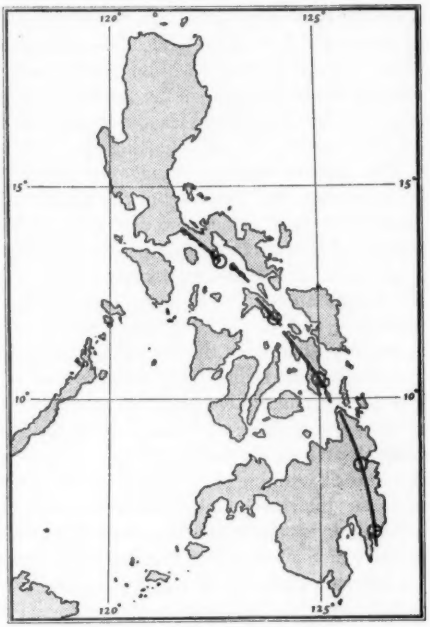


Fig. 3. Philippine Arc

If we draw a great circle through the Kurile and Philippine poles (its own pole is in 14° N., 24° 37′ E.) it will be found that the Riu Kiu pole lies 1° 53′ from this great circle, upon its western side, the East Indian pole 0° 25′ from it upon its western side, and the Japan pole 4° 28′ from it upon

*Lake, *Geol. Mag.*, 1931, pp. 34–39.

†Professor Sollas draws a circle grazing the west coast of Honshiu, which seems to give a pole not far off mine, but his map is on a very small scale. Kumagai (*Jap. Journ. Ast. and Geophys.*, vol. viii, 1930, pp. 1–28) bases his work upon the locus of points midway between the submarine contours of 200 metres on each side of the islands. When he includes Hokkaido he finds the best pole at 42° 37′ N., 130° 23′ E. Excluding Hokkaido the best pole is at 41° 0′ N., 131° 46′ E. But the locus of middle points departs considerably from a circle.

its eastern side. Leaving the Japanese arc out of consideration for the present, it will be seen that the other four lie so nearly on a great circle that there must be some reason for the coincidence. It should be remembered that the thrustplanes to which they probably owe their circular form crop out beneath the sea; and the poles have not been determined from these outcrops but from geological features generated by movement upon the planes. Judging from the analogy of exposed mountain ranges it is to be expected that these features will be approximately concentric with the outcrops of the thrustplanes. But they are not necessarily exactly so, and it is not unlikely that the poles of the actual thrustplanes at the bases of the Kurile, Philippine, and East Indian arcs lie even more nearly upon the same great circle.

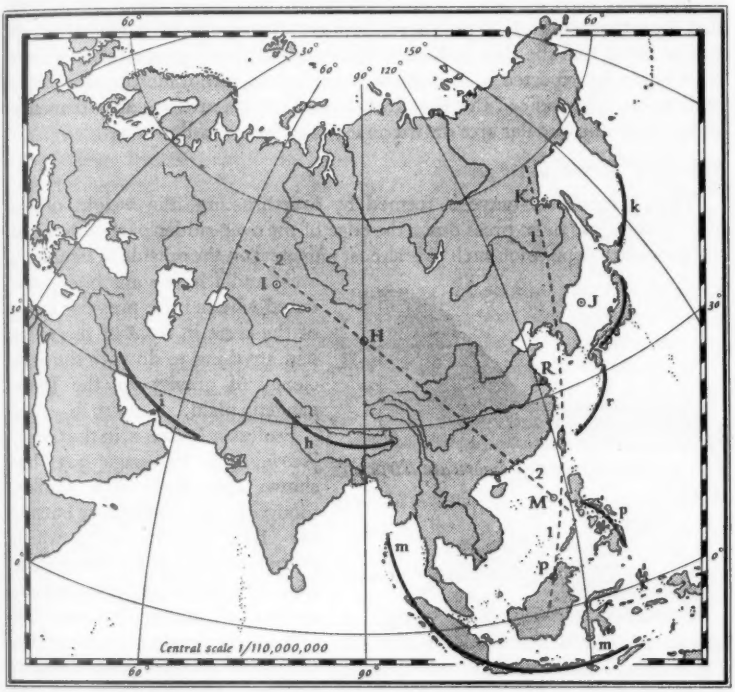
It has already been noted that when the poles of a series of thrustplanes lie upon the same great circle, the thrustplanes themselves are all at right angles to the plane of the great circle. Movements along them at right angles to the plane of the great circle will be parallel, and such movement will be possible without any breaking up of the moving mass. If, on the other hand, the thrustplanes are not at right angles to any common plane, movement upon them will not be possible without a breaking up of the moving mass into separate blocks.

The observations accordingly suggest that the Asiatic mass as a whole is being pushed over the floor of the Pacific upon a series of thrustplanes, in a direction at right angles to the great circle indicated. In the case of the well-formed island arcs the basal thrustplanes are at right angles to the plane of the great circle: in the case of the imperfect arc of Japan the basal thrustplane is not at right angles, the movement upon it has therefore been accompanied by fracturing, and the arc is broken. The general conception that the Asiatic mass is being pushed over the Pacific floor is due to Suess, and the details here brought forward strongly support this idea.

A question naturally arises as to the reason why thrustplanes in the north and in the south of Asia, which seem to be independent, should, as if by common consent, arrange themselves at right angles to an agreed plane. It is probable that at the beginning of the movement the fractures were numerous, small, and irregular; but since parallel movement would require no expenditure of energy in breaking up the mass, there would be a tendency for those faults or thrustplanes which allowed it to become predominant.

Hitherto, adopting the usual convention, I have spoken of the direction of overthrusting as the direction of movement; but the movement is relative, and there are reasons for thinking that it is due to underthrusting of the ocean-floor rather than to overthrusting of the continental mass. In the East Indian arc the direction of overthrusting is towards the Indian Ocean and not towards the Pacific; and farther west, in general, the overthrusting along the southern border of the mountain belt is also to the south or south-west. There is, accordingly, an Asiatic mass with overthrusting along its eastern border towards the Pacific, and overthrusting along its southern border towards the Indian Ocean. A movement of the mass as a whole in both directions is not possible, but underthrusting of the ocean-floor from both sides is conceivable and is, in fact, a necessary consequence of the contraction theory or of Joly's theory. Such an underthrusting would be accompanied by a wedging up of both borders.

It would be interesting to know whether the poles of the chief arcs upon the southern border of the mass lie upon a common great circle. The arcs are far more complex than on the eastern side, there seems to have been more interference with their regular formation, and the danger of being misled by accidental coincidences is much greater. For these reasons I have hesitated to investigate the matter, but some sort of preliminary attempt seems desirable.



k *Kurile Arc with its Pole at* K
j *Japan* " " " " " J
r *Riu Kiu* " " " " " R
i *Iranian* " " " " " I
p *Outer Philippine Arc with its Pole at* P
m *East Indian* " " " " " M *(after Sollas)*
h *Himalayan* " " " " " H (" ")
1 *Great Circle passing through Kurile and Philippine Poles*
2 " " " " *East Indian and Himalayan Poles*

Fig. 4

In order to eliminate the personal equation as far as possible I decided to take Professor Sollas's results for the East Indian and Himalayan poles, and to find a pole for the Iranian arc by his method of trial upon an 18-inch globe. These are the three great arcs concerned, but Professor Sollas did not deal with the last. According to my trials the best result was obtained with a pole at 49° N., 71° E., and a radius of 24°. These are the elements for the arc as shown on Fig. 4. It ignores the bulges on both sides of Bandar Abbas, but agrees very well with the general form.

The next step was to find the pole of the great circle passing through Sollas's Himalayan and East Indian poles. It lies at 34° 48′ N., 141° 16′ W. A further computation shows that my Iranian pole lies 1° 25′ from this great circle, upon its southern side. Considering that the poles of the East Indian, Himalayan, and Iranian arcs were only determined to the nearest degree, the coincidence is as close as could be expected. The evidence is not so satisfactory as in the case of the more clearly defined arcs upon the eastern side, but it distinctly suggests that the movements which produced these great arcs were not independent. It will be noted that the East Indian arc lies nearly on both great circles. This is what might be expected in the case of a corner arc, with underthrusting from both sides. The radii of the East Indian and Iranian arcs are approximately equal. Both the circular arcs drawn on my map have a radius of 24°.

Subcrustal Mountain-ranges

When a mountain-range is formed by overthrusting, the weight of the over-riding mass must press down the edge of the over-ridden part of the crust and produce a depression such as is almost universal on the outside of mountain arcs; and I have sometimes wondered whether the pressing down of the crust in front of the range had anything to do with the deficiency of gravity in the Indo-gangetic plain.

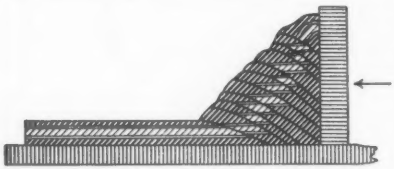


Fig. 5. Development of Imbricate Structure (Cadell)

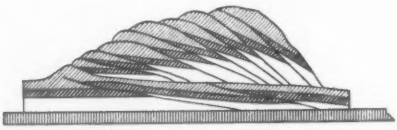


Fig. 6. Major thrustplane or "sole" (Cadell)

Professor Meinesz, in the *Geogr. Journ.*, vol. 77, page 323, has shown that there is a similar, though greater, deficiency outside the East Indian arc, which probably rests upon a thrustplane also. The belt of negative anomaly ignores all minor features but follows the general course of the arc with considerable fidelity. Professor Meinesz points out that the only reasonable explanation of this belt is that there is here a downward protuberance of the lighter crust into the denser material below; and this protuberance must be much greater than the upward protuberance which forms the arc itself. In other words, outside the superficial mountain-range which forms the East Indian arc there is a subcrustal inverted mountain-range which greatly exceeds it in magnitude.

In this connection the experiments of Cadell* are of interest (see Figs. 5 and 6). They were undertaken primarily to elucidate the characteristic structures of the North-West Highlands. A series of alternate hard and soft beds was subjected to tangential pressure. In the early stages of the experiments a heaped-up mass was formed at the end where the pressure was applied. The heaping-up was due to steeply inclined thrusts; but after it had reached a

**Trans. Roy. Soc. Edinb.*, vol. xxxv, pp. 337–357. A summary is given in 'The Geological Structure of the North-West Highlands of Scotland,' p. 473.

certain magnitude, a gently inclined thrustplane was formed at the base of the mass and upon this the whole mass slid forward over its foreland. Further application of pressure led to the production of other thrustplanes beneath the first, and cropping out in advance of it; and thus successive slices of the foreland were involved in the movement.

The experiments imitated very closely some of the chief features which are seen in overthrust mountain-ranges. But in one respect they failed to reproduce the actual conditions. The beds rested upon a rigid floor. Downward movement was impossible and no question of isostasy could arise. In the actual crust, underthrusting will produce an inverted subcrustal mountain-range just as overthrusting produces a superficial mountain-range visible to our eyes. The great mass of the superficial range, both in actual fact and in Cadell's experiments, lies far behind the superficial outcrop of the basal thrustplane; and, correspondingly, the great mass of the subcrustal range should lie far behind (from its inverted point of view) the subcrustal outcrop of the thrustplane. Consequently the subcrustal range may lie outside the superficial one, as it appears to do in the case of the Himalayan and East Indian arcs.

It seems that at this stage gravity should be in excess on the superficial range and in defect over the subcrustal one. But, as the movement goes on, the subcrustal range will be pushed under the superficial one and the gravity anomalies will disappear. There are several points in this explanation which might be further elucidated, but for the present I prefer to leave it as a tentative suggestion which corresponds very closely with the facts of observation.

DISCUSSION

Before the paper the PRESIDENT (Admiral Sir WILLIAM GOODENOUGH) said: Not only we in this Society but a great many other people owe Mr. Philip Lake very much. For many years he was Reader in Geography at Cambridge, and there can be no doubt that it was his very able handling, with others, of that study which brought geography to the fine pitch that it has reached at this moment. It must be a gratification to him to have seen that the readership has been raised to the status of professorship. Mr. Lake has been a member of our Council, and on the subject on which he is going to address you this afternoon he is not only a pastmaster but a present master, and I have no doubt will be a future master. With that I ask Mr. Lake to address us.

Mr. Lake then read the paper printed above, and a discussion followed.

Sir GERALD LENOX-CONYNGHAM: I should like to express my gratitude to Mr. Lake for his paper. It appears to me to be new—it was new to me at any rate—that the explanation of the circular form of island arcs and mountain ranges was so simple and so complete: that if you have a thrustplane its intersection with the surface of a sphere must necessarily take a circular form. Also the other geometrical point, the connection between the radius of the circular arc and the dip of the thrustplane, was new to me, and I think probably to a great many others. It is very simple and very beautiful.

Mr. Lake interested me very much when he pointed out that there is evidence that the thrusts have not been from the continent of Asia outwards but from the Pacific and Indian Oceans inwards, that there is underthrusting and not overthrusting. That seems to me to agree, as Mr. Lake said, exactly with what Dr. Meinesz told us not long ago in this hall when trying to account for the negative

anomalies in gravity that he had found outside the island arc of Sumatra, Java, and the other East Indian islands. It seems to me now that we must look upon mountains as secondary phenomena; that we must look, first, to the crushing and folding of strata a good way down, perhaps (to take the figure from Dr. Meinesz) 40 or 50 miles down below the surface of the sea; and that the first effect is to produce what Mr. Lake has called an inverted sub-crustal range which will be much more voluminous and contain much more matter than the range of mountains that we see ultimately formed on the surface. If we start with the idea of the folding taking place low down and causing an underthrust which leads to the formation of mountains on the surface it throws the whole process into truer perspective. In the formation of the inverted range there will be two processes going on simultaneously, first the downward folding whereby less dense matter will be thrust down into the heavier magma, and secondly the flotation forces striving to restore isostatic equilibrium. These forces will lift the whole mass vertically. This agrees well with what has been often put forward by Dr. Bowie of the United States Coast and Geodetic Survey, namely, that a great deal of mountain formation has been caused by purely vertical uplift, not by lateral crushing. It appears to me, sir, that Mr. Lake's paper, coming so soon after that of Dr. Meinesz, which is published in the April number of the *Journal*, strongly corroborates the latter in promoting clearer ideas about the formation of mountains.

Dr. H. R. MILL: I must express my admiration of the extraordinary lucidity with which Mr. Lake has dealt with a really complicated subject. I have not been able recently to do much in the way of reading up those geotectonic questions which are so closely and fundamentally related to geography, and it has been one of the greatest pleasures I have had for a long time to listen to Mr. Lake expounding the connection between the form and the formation of those wonderful circular arcs of mountain ranges and island groups the outlines of which on the map are so fascinating. One point which Mr. Lake did not mention explicitly —though I think he did so inferentially, and it was no doubt present in his mind— is the frequency with which deep troughs of the ocean floor lie alongside the convex sides of the island arcs. Outside the Aleutian Islands, Japan, and the Philippines, and also along the great arc of Sumatra and Java, there are sharply defined, narrow, and very deep troughs running either concentric with or tangential to the island arc. The study of the relation between land ridges and ocean troughs should bring a considerable body of evidence to bear on the question of the double thrust Mr. Lake refers to—the underthrust from the ocean and the overthrust from the land. I should like at some other time to hear the subject dealt with in greater detail. The pleasure of this afternoon's meeting has been enhanced by the admirable method in which the illustrations have been shown on the screen, with a map and a diagram or picture side by side so as to present horizontal and vertical outlines simultaneously.

Mr. N. E. ODELL: It has been a great pleasure to me to be here this afternoon to hear Mr. Lake on this extremely difficult subject of mountain building. I have not had the advantage of visiting more than two of the localities of which Mr. Lake has been speaking, but it has been my privilege to see something of Southern Persia and also of the eastern central portion of the Himalayan range during the last Mount Everest Expedition. Regarding Southern Persia I will only say that the Iranian arc, as traced by Mr. Lake, would appear to correspond very fairly with the folded Alpine system recently described by Messrs. de Böckh, Lees, and Richardson (J. W. Gregory, 'The Structure of Asia,' Chap. III), wherein overfolding takes place in a southerly direction.

Mr. Lake has told us that it is possible that in the great Himalayan chain the

main sense of the movement may be one of overthrust from Central Asia towards the south. Equally I rather understood from his remarks that we may consider the movements there to be those of underthrust; that is to say, underthrust of the continental mass, India, towards Central Asia. My reading of the structure locally in the very small portion of the arc in Northern Sikkim and westwards rather suggested to me—and I am shortly hoping to work on the problem—that in that particular portion we should consider underthrust to be the main sense of the movement. Comparing that portion of the Himalayan arc with the very much better-known structures of the Alps we have nothing of the great recumbent anticlines that are so prevalent in the Alps, and which have been described by so many workers the whole way along the Alpine chain. We have, as far as the foreland or "creative block" is concerned, the old continental mass of India, and the great deep down-sunk area, the fore-deep of the Gangetic trough. We then have a great mass of rocks, some of which are extremely crumbled, many of which have undergone a great degree of metamorphism. And then we have along the border of the Tibetan plateau relatively uncrumbled strata; we have fairly gentle corrugated folds of the Triassic and Jurassic and certain Cretaceous strata; we have, as far as has been discovered in Sikkim and to the east, nothing of the nature of great tectonic outliers, or "Klippen," that is, portions of the latter rocks left isolated upon those of the crumpled zone. We have reverse faults on a small scale, but the great boundary fault that Middlemiss was able to identify as running along a considerable portion of the north-western part of the Himalayas has not been identified at all from the work of Sir Henry Hayden, Professor Garwood, and others in that particular section of the Himalayan arc I am speaking of. My own reading there is: that the Himalayan chain has been decidedly underthrust, the main mass of India moved towards the Himalayan arc, and the strata down-folded in the Gangetic trough; then that there has been a buckling of strata and mashing together of the rocks in the borderland of Sikkim; and lastly that the stress has not been transmitted to the sediments of Tibet in any very great degree. Briefly I feel that the evidence in that particular section of the Himalayan chain is rather suggestive of underthrust from the south, with India as the active block, than of the overthrusting of Tibet southwards towards India. But perhaps Mr. Lake's hypothesis may provide for such an operation in a portion of the arc; in fact, I rather gathered it might.

And then, coming to the possibility of general application of the hypothesis, but without wishing to extend unduly the very interesting idea that Mr. Lake has been applying to this particular Tertiary system of mountain chains in the east of Asia, I should like to ask him a question: that is, whether he would wish in any way to endeavour to apply this idea of circular arcs to other great ranges, whether of Tertiary or older age. The great Andean and Rocky Mountain chains stretch in more or less straight lines for the greater part of their length, save in Alaska, where strict arcuate form is attained, and in other portions less so. The ancient Caledonian Mountain chain, extending across the British Isles, continues in a straight line up through Norway to the region of the North Cape. Thence the main trend appears to be northward through Spitsbergen, from there probably, though not certainly, taking a sharp turn westwards through Northern Greenland. Great portions of the chain are however remarkably straight. I should like to know how Mr. Lake would conform such straight trends to his hypothesis.

In conclusion, might I say how much I have appreciated Mr. Lake's most interesting and stimulating paper? I hope to read it in detail and follow up later some of the problems suggested by it.

The PRESIDENT: I should be glad if there is anybody from any kindred society, whose name I do not happen to know at the moment, who would care

to speak. If not, I ask Mr. Hinks, the Secretary of this Society, to say a word or two.

Mr. A. R. HINKS: I am sure, sir, we have all been very charmed with the simple and elegant geometry which Mr. Lake has so convincingly placed upon the screen. There is just one point upon which I should like to have the opportunity of asking a question. If I understood him aright, the circularity of the arcs shows that the thrustplane is a real plane; that is to say, that it cuts across the more or less spherical surfaces with which we are familiar from the work of geodesists and others, the granite and intermediate layer and the lower layer. I should have supposed from the very little I have read upon the subject and a good deal of talk I have had with Dr. Meinesz in the last six months that the thrusts and the forces must be acting, so to speak, along a spherical surface; they must be transmitted through particular geomorphic layers. I should like to ask Mr. Lake how he imagines that the thrusts and the forces which, as far as I understand, sheer the Earth along this clean, true plane, are produced and how they are transmitted. I do not know whether that is a fair question.

Mr. LAKE: Mr. Odell is inclined to think that in the case of the Himalayas the movement is underthrusting rather than overthrusting. That was my conclusion also, but in my preliminary account I spoke of the direction of overthrusting according to the usual convention. Actually I imagine that it is a case of underthrust on both sides, from the Pacific and from the Indian Ocean; and I am glad to find that Mr. Odell agrees.

With regard to Mr. Hinks's question, it is hardly possible here to go into the matter fully, but I should like to suggest that, considering Asia as a whole, the movement is not unlike the type of movement which I think he has in mind. The general effect of a series of small thrustplanes, all at right angles to the plane of a great circle, approximates to that of a single thrust-surface which follows the curvature of the Earth but remains always at right angles to that same plane.

The PRESIDENT: The circumstances of my life have not given me the time or opportunity to study this subject. I should like to thank you, Mr. Lake, personally, for having introduced into my life, somewhat late perhaps, a subject which I can see is never ending in interest. I am sorry to hear, for the sake of Mr. Hinks and Mr. Lake, that Mr. Lake is going back to Cambridge at once, while Mr. Hinks will stay in London; otherwise, I am sure they would have had a conversation that would have lasted into the early hours of to-morrow morning. On behalf of the Society, Mr. Lake, may I offer you our warmest thanks for introducing us to a very intricate subject? I was going to ask you, quietly, one or two questions which I would not dream of putting to you in public, such, for instance, as where the pressures start, how far off or how far down, and that sort of thing; but I will not cause you to lose your train. Please accept therefore, Mr. Lake, our warmest thanks for a very interesting lecture. Thank you very much indeed.

TECTONIC GEOLOGY OF THE MEDITERRANEAN

DISKORDANZ UND OROGENESE DER GEBIRGE AM MITTELMEER. By W. von SEIDLITZ. *Berlin: Gebrüder Borntraeger* 1931. 10×7 *inches;* xxiv+652 *pages; illustrations and maps. M.*72 (*paper covers*); *M.*75 (*bound*)

THE mountains and basins of the Mediterranean area may well be regarded as the *Enigma Variations* of tectonic geology. Many of the individual variations, from the Sierra Nevada to the Taurus or the Balearic Islands to Crete, have been intensively studied, but no detailed analysis of all of them on anything approaching the scope of the present volume has hitherto been attempted. The author is well equipped for the ambitious programme he has presented, for during the last twenty years he has worked in Andalusia and the Balearic Islands, the south and east Alps, Italy, Dalmatia, the Ionian Islands, Egypt, and Syria. Moreover, he has taken full advantage of every possible method of approach, and assembled the results in so masterly a way that one feels that tectonic geology has at last emerged as a definite branch of science capable of orderly progress towards a horizon that is no longer enshrouded in fog. At the moment, despite an overwhelming abundance of observational data, only a minimum of definite conclusion has been reached, but there is a growing realization that the mystery, while it still remains, *can* be unveiled, given the means. The ultimate possibility of a genuine solution seems no longer to be in doubt. What is needed, of course, is more geophysical data; more probing of the hidden depths, and particularly of those beneath the sea. There are workers available in plenty, but few Governments, even of earthquake-ridden lands, have hitherto provided the financial assistance that is necessary for continuous large-scale cooperative research. Meanwhile, as a result of the indefatiguable labours of three generations of geologists, including his own, Professor von Seidlitz has been enabled to give us a geological picture of the Mediterranean and its mountains which, though it is necessarily bound up with current hypothesis, constitutes a far more accurate statement of the problem than has ever before been practicable.

It need not be a matter for surprise that the completed picture is one of greater complexity than those offered by Suess or Kober. The latter introduced the very fruitful idea of median areas lying between ranges overthrust to the north over Europe and to the south over Africa. Von Seidlitz develops this conception, and arrives at a three-fold system of mountains, with the Pyrenees and the Caucasus as additional wings on the European side. The central line, representing the main geosyncline and characterized by bathyal sediments and ophiolitic and ultrabasic igneous rocks, is traced from the Sierra Nevada to the Alps (*via* the Sardinian edge of the Tyrrhenian Sea and the overthrust north-east corner of Corsica), and beyond through the Dinarics to the Taurus. The northern line includes the Carpathians and the Balkans, separated from the central line by the Pannonian and Thracian median areas. The southern line extends from the Tell Atlas through the Apennines and South Alps to Dalmatia and the Hellenic arcs. These are separated from the central line on the west by the median areas of the Algero-betic mass (mainly sea-floor) and the Tyrrhenian Sea, and on the east by the median areas of the Cyclades (largely inbroken and still tectonically active) and Lydia (Western Asia Minor). South of the southern line is the Algerian meseta, passing laterally into the Eastern Mediterranean with the Adriatic as a north-western prolongation extending *via* the Po valley towards the very core of the Alpine system, and acting as a foreland to both the Apennines and the Dalmatian Dinarics. Allowing for the Sahara Atlas and the folds of Egypt and Syria, all of this area is a kind of peripheral median area or mobile

shelf bordering the foreland proper of Africa. Thus the southern foreland, largely sunken, is of a very different character from its northern counterpart. The latter is fortified with the old Hercynian blocks of the Iberian meseta, the Central Plateau of France, the Vosges and Black Forest, and the Bohemian massif.

It is clear in a general way that the mountains have arisen along the major and bordering geosynclines during the struggle for space resulting from the relative approach of Africa and Europe. The median areas have been in some cases squeezed up, but in others, more numerous, they have broken up and subsided wholly or in part. The median areas are often bordered with recent or Upper Tertiary volcanoes, particularly where they have been crossed by later transverse faults. The sunken foreland of Africa however is practically free from volcanoes. The nature of the Adriatic is one of the most puzzling features. Is it a residual geosyncline, or a migrational geosyncline, or a sunken part of an original protuberance from primaeval Africa which was pushed far into Europe? Von Seidlitz directs attention to the spiral-like arrangement of the structural lines that swing out from Provence: the Carpathians and Alps, the Dinarics and Southern Alps, the Apennines and Tell Atlas, the Corsica–Balearic–Betic line, and the Pyrenees. This arrangement seems to imply an interfering system of substratum currents: one from Africa, spreading out towards the Western Alps and the Carpathians; one from France and Spain directed towards Sicily; and one from the Russian Shelf directed towards Greece. But the question arises whether an African current up the Adriatic is really essential; if not, then there is nothing otherwise in the Adriatic area to suggest that it was originally part of Africa.

Another serious problem is that of the mechanism responsible for the subsidence of much of the Corsica–Sierra Nevada chain and the median areas of the Western Mediterranean. With regard to the former it is possible that there never was a continuous chain. Even if the major geosyncline had been originally continuous—an assumption for which there is no evidence—the thicknesses of accumulated sediments must have varied with the nature and behaviour of the adjoining islands and shores of the Tethys. A part of the geosyncline that remained empty, or nearly so, could hardly be squeezed into a mountain chain, whatever the pressure. The association of the subsided median areas with transverse faults is a feature that is stressed by von Seidlitz. The Erythraean north-west to south-east faults of Africa, well displayed in the form of the Red Sea, appear to cut through the Aegean area, separating the Cyclades and Lydian median areas and breaking the continuity of the main mountain ranges. A parallel fault zone runs through the Ionian Islands into the Adriatic. Another displaces the mountains of Calabria and Sicily, and another those of Sicily and Tunis, while smaller ones cross Cor-Sardinia and the Balearics. These shear faults appear to follow a dominant direction of Hercynian faulting, but their movement in the Mediterranean was obviously later than most of the Alpine folding and overthrusting. Cross faults are less conspicuous in the structural design, but they are found, corresponding in direction to the Somali direction of Africa (Gulf of Aden), in Crete, Cyprus, and Rhodos, and in Greece and the Balearics. These fracture systems can be interpreted as the result of continued pressure from Africa after the whole Mediterranean area had been stiffened by mountain-building. But mere fracturing is clearly incompetent to promote subsidence. A push which displaces the pieces of a jig-saw puzzle does not make any of them sink into the table on which they are lying. In the Mediterranean the effect of the pressure has been so to modify the material in depth that the surface layers could subside. Squeezing out of magmas can at most have been only a secondary process, for the volume of igneous material around the rims is

minute compared with the volume of the sea-basins. Only one process known to the writer seems adequate to meet the requirements, and that is the thermodynamic metamorphism of the basic material underlying the continental crust into eclogite. Von Seidlitz does not refer to this possibility or discuss the necessity of bringing the subsidence into accordance with isostasy. He does however favour the idea of interfering current systems in the substratum, and it is only one further step to realize that the effect of the consequent shearing movements on the overlying basic layer would be the production of eclogite with a corresponding 10 per cent. decrease in volume. The detailed study of the records of near earthquakes in the Mediterranean would go far towards settling this fundamental question of the mechanism of subsidence.

To all who are interested in the major problems of physical geology and geomorphology and able to read clear and simple German, this magnificent book of von Seidlitz will be a sheer delight. It contains a valuable summary of all the data, stratigraphical, palaeogeographical, petrological, geophysical, etc., which bear on the area. Twenty-six chapters are devoted to the geology and tectonics of the far-flung Mediterranean lands, and for this reason alone geologists will welcome the book as an invaluable source of information and references. The illustrations are lavish and effective, and include twenty-nine reproductions of photographs and 140 maps and sections. There is a very long bibliography and a thoroughly adequate index. The price may seem high, but the book stands out in the flood of German geological literature as one of quite exceptional importance. Its value is to be reckoned not at so many pages per mark, but in terms of its author's competent treatment of a subject that has never before been dealt with so comprehensively. The book is a well-balanced survey that is authoritative as to facts, sane in its judgments, and restrained in speculation and in its conclusions. The prospective purchaser need not be deterred by the price, if he can afford it, for he will certainly not be disappointed. ARTHUR HOLMES

THE REGIONAL GEOGRAPHY OF SIEGFRIED PASSARGE

DIE GRUNDLAGEN DER LANDSCHAFTSKUNDE. By S. PASSARGE. Band I, Beschreibende Landschaftskunde (Zweite Auflage, 1929); 210 *pages*. Band II, Klima, Meere, Pflanzen und Tiere (1920); 222 *pages*. Band III, Die Oberflächengestalt der Erde (1920); xxx+558 *pages*. Band IV, Der Mensch in der Landschaft (in Vorbereitung). *Hamburg: Friederichsen, de Gruyter & Co.*

VERGLEICHENDE LANDSCHAFTSKUNDE. By S. PASSARGE. Heft 1, Aufgaben und Methoden (1921); viii+72 *pages*. Heft 2, Kältewüsten und Kältesteppen (1921); viii+164 *pages*. Heft 3, Die Mittelgürtel (1922); viii+100 *pages*. Heft 4, Der Heisse Gürtel (1924); xviii+168 *pages*. *Berlin: Dietrich Reimer (Ernst Vohsen)*.

LANDSCHAFT UND KULTURENTWICKLUNG IN UNSEREN Klimabreiten. By S. PASSARGE. *Hamburg: Friederichsen, de Gruyter & Co.* 1922. iv+166 *pages*.

STADTLANDSCHAFTEN DER ERDE. Herausgegeben von S. PASSARGE. *Hamburg: Friederichsen, de Gruyter & Co.* 1930. vi+154 *pages*.

DIE LANDSCHAFTSGÜRTEL DER ERDE. By S. PASSARGE. (Jedermann's Bücherei.) (Zweite Aufgabe, 1929). *Breslau: F. Hirt.* 144 *pages*.

DURING the past decade there has been a development of geographical method which is of great importance for the future of the science. The seed was sown by Herbertson in his paper, published in the *Geographical Journal* in 1905, on "The Major Natural Regions: An essay in Systematic Geography," but since that time marked developments have taken place in Central Europe. Some idea of the extent of this movement may be gathered from the bibliography, running to hundreds of entries, given by J. G. Granö in his work 'Reine Geographie,' published by the Finnish Geographical Society in 1929. Of the workers in this field, Professor Passarge of Hamburg stands out because of the originality of his methods and the wide range of his own publications, besides the stimulus he has given to regional work by his students, and the discussions to which he has contributed in the geographical journals. Yet the number and form of Passarge's works makes some kind of a guide desirable, and the present note aims at showing the relationship of the works named above to each other and to Passarge's theories.

The key to the leading idea in Passarge's work is given in the title 'Vergleichende Landschaftskunde,' and it is therefore necessary first to explain this term. In ordinary German "Landschaft" means "landscape," and this meaning is still retained by geographers; but in addition the word has come to be the equivalent of "environment," and finally of "region"—in the sense of a definite area of the Earth's surface including not only the natural phenomena but also the works of man and man himself. Passarge's work is therefore concerned with the determination and study of "Landschaften" as unit areas of geographical research. This is of course no new conception, though the methods have undergone considerable changes in recent years, but a marked development is suggested by the adjective "vergleichende," for in the establishment of types of regions and the comparison of regions of the same type, the originality of Passarge is unquestionable.

The necessary fundamental knowledge is given in the series placed first in the list at the head of this note: 'Die Grundlagen der Landschaftskunde,' the first volume of which is devoted to "Beschreibende Landschaftskunde," a volume which directs attention, and gives precise names, to the phenomena which a geographer encounters. This book may therefore serve as a vocabulary for English

readers who wish to acquire a thorough knowledge of German technical terms. It also gives short examples of the technique of regional observation. The second volume deals with the phenomena of the sea, the atmosphere, and plant and animal life. The third volume is a much more thorough study of land forms and their origin, emphasizing two aspects which bear on Passarge's regional work. The first is that it is the special province of geologists to examine the past events which have contributed to the development of relief, and of geographers to examine those processes which are at work at the present time. The various forms of erosion and deposition are therefore very fully investigated. The second feature is the attention given to the land forms associated with particular types of climate, a matter which Passarge has also worked out in his monograph, 'Klima und Landschaftsbild' (1927). The fourth volume on 'Der Mensch in der Landschaft' is not yet published.

The essentially new ideas are however contained in the second series, 'Vergleichende Landschaftskunde,' the first part of which examines the scope and methods in a general way. Passarge holds that the unit of geographical study is the "Landschaft," an area with a characteristic grouping of phenomena; the size of a Landschaft may vary, but as examples one may give the Harz and the Spreewald, the former owing its unity to relief, the latter to drainage conditions. The "Landschaft" is not, of course, uniform; and it is regarded as composed of unit areas of a lower order, "Teillandschaften," while these again disclose "Landschaftsteile," the elements of surface distributions, *e.g.* wooded slopes, meadow valley-bottoms, ponds, dunes, etc. Regions of higher orders are "Landschaftsgebiete," usually characterized by a certain unity or obvious grouping of surface form within a definite vegetation and climate area; thus the North German Plain is regarded as a Landschaftsgebiet within the Central European Forest region with a cool temperate climate which would form a region of the highest order, the "Landschaftsgürtel."

Single regions of each order may be compared with one another and grouped into types, and it is the types rather than the particular examples with which Passarge deals; further, he has devised a nomenclature for these types which he regards as necessary for systematic treatment. Thus the Landschaftsteile are denoted by relatively simple terms such as Schilfsumpf-Mulde, but to indicate the essential characteristics of Landschaftsgebiete may require such a lengthy expression as "glaziale aufgeschüttete Sumpfwald-Flachländer."

In the determination of the regions Passarge takes into account only the physical characteristics, excluding climate, and the natural vegetation; therefore in many parts of the world he has to go back to the condition of the region before man modified it, as far as that can be ascertained. It is on this non-human basis that his system is developed. Further, "ideal" regions are worked out, which embody the common characteristics of the types as distinct from the particular features of individual areas. On the other hand, the relations between these physical and vegetation regions and their animal and human inhabitants are also considered. In the Local ("Räumliche") Regional Geography it is shown how the life of animals and man depends upon each particular region, how man has created the "Kulturlandschaft," and what possibilities of advance nature offers to him in that area. In the Comparative Regional Geography these matters are again generalized. A thorough discussion of these and many other aspects of the method, with its relation to other branches of geography, *e.g.* Landeskunde, and to other sciences, is included in the first part and taken up again in the foreword to the fourth part.

The second part applies the method to the cold steppes and cold deserts of the world, both those of polar and sub-polar areas, and also those of high altitudes

in the temperate and tropical zones. The cold steppes (to take one example of the general method of systematic classification) are divided into two classes, those of polar situation and those of high altitudes; the former are again divided into two sub-classes: the tundra lands and the sub-polar meadow lands. The tundra sub-class has two "orders," the lowlands and the uplands; the lowland order includes three "families": areas of glacial deposition, of glacial erosion, and areas not glaciated. Each family again is divided into "genera," *e.g.* according to the type of deposition, and these again into "species," in which the surface form is the criterion. Sketch-maps show the distribution of the larger regional types.

The third part deals with the much larger and more complicated group of regions of temperate climates. The method is similar but the scope is so great that only the regions themselves can be dealt with; consequently a supplementary study on the human aspects is published separately under the title 'Landschaft und Kulturentwicklung in unseren Klimabreiten,' and this devotes approximately half its space to developments in Europe. The fourth part of the main series is given to the Tropical Regions from the physical point of view, and a fifth part, which will deal with their human aspects, is promised but has not yet appeared.

Professor Passarge holds that cities are in themselves "Kulturlandschaften." As a first attempt at a special study of cities on these lines he has collected in 'Stadtlandschaften der Erde' nine essays by as many writers dealing with the cities of various parts of the world. He himself contributes a preface and the essay on "Stadtlandschaften im arabische Orient," but the other writers are allowed to treat the cities of their respective regions on their own lines; no uniform system is attempted.

In conclusion, attention may be directed to the short and popularly written account of the major regions and their peoples which Passarge has published in Hirt's 'Jedermann's Bücherei,' but his book on 'Südafrika' (published in 1908) is not included in the above list as it was a first attempt at a regional division which subsequently seemed unsatisfactory to the author and does not incorporate his later ideas. It will be realized that the aim of this notice is merely to indicate the scope and the form of presentation of Professor Passarge's regional work, and that adequate appreciation and criticism would require far more space than is here available.

J. F. UNSTEAD

REVIEWS

EUROPE

GÉOGRAPHIE DE LA SAVOIE. By R. GODEFROY. *Chambérg: Dardel* 1930. 9×6 *inches;* 186 *pages; diagrams and maps.* 20 *fr.*

This is an account in two parts, general and regional, of that varied and interesting country which lies between the Lake of Geneva and Briançonnais. The book is the work of a well-known *alpiniste* and is heavily weighted on the geomorphological side. Part I carries the reader through the geographical cycle from nature and structure of the rocks, through relief and climate, to land utilization and distribution of population. Part II, about one-third of the volume, deals with the natural regions. The great zonal Alpine divisions—the crystalline massifs, the Alpine trough and the border uplands—are subdivided into natural regions which bear a definite relation to the main transverse and longitudinal river valleys.

The space devoted to this section of the work is relatively so small that the author has been unable to develop his correlations for physical and human elements in a very satisfactory way; indeed, in a number of places the description degenerates into a mere catalogue and the reader is obliged to turn back to the general section to find the detail he needs to build up a mental picture of the region. Nevertheless the author manages to convey a great deal of interesting and relevant matter in a short space which he has wisely eked out by the use of clear maps and diagrams, and we welcome the book as filling one of the gaps still left in the detailed regional studies of France. H. O.

EL TÚNEL SUBMARINO DEL ESTRECHO DE GIBRALTAR. By Lieut.-Col. PEDRO JEVENOIS. *Madrid: Editorial Voluntad* 1927. 10×6 *inches;* 396 *pages; illustrations and maps.* 13*s* 6*d*

The object of the author in publishing this treatise is to show that the project of a tunnel under the Strait of Gibraltar is technically and economically sound and that although the geological and physiographical data at present available are insufficient for the purpose of a complete design or even for the determination of a precise location, yet there is a *primâ facie* case for a detailed study of the conditions and justification for the outlay to be incurred in a properly organized and systematic investigation. He urges that it is a national obligation on the part of Spain to undertake the preliminary work with a view to carrying through an enterprise which will confer great and lasting benefits, not merely on the Spanish nation, but on the whole civilized world, by linking up the main lines of communication across the continents of Europe and Africa with their extensions into Asia.

The author commences by reviewing the proposals of various kinds which have been put forward from time to time for traversing the Strait, comparing them with similar proposals elsewhere, such as the Channel Tunnel and the tunnel advocated between Ireland and Scotland. Some of these proposals involve constructional novelties of an interesting, but at the same time dubious, and even fantastic character. Whilst claiming an open mind on the subject, the author concludes that on the information available an underground tunnel is the only likely satisfactory solution of the problem, and he therefore proceeds to give it detailed consideration.

He has to confess that up to the time of writing only very general ideas ("nociones abstractas") prevail as to the geological structure of the Strait. Recounting such publications on the subject as have appeared and commenting on

their statements he finds satisfactory evidence that the geological formation of the bed of the Strait belongs to the Eocene group of the Tertiary System, consisting of impermeable argillaceous beds lying over siliceous or calcareous strata. He relies very largely on the testimony of Señor D. Enrique Dupuy de Lome, whose opinions he quotes to the effect (1) that the geological formation is the same on both sides of the Strait; (2) that there exist impermeable eocene and cretaceous beds below which a submarine tunnel can be driven without fear of excessive infiltration; (3) that there are probably some faults which must be almost hermetically sealed, since they lie in an argillaceous environment; and (4) that in order to discover the best location it will be necessary to make a close geological study of the coasts.

As regards the location of the tunnel, the author points out that while the narrowest part of the Strait has a width of only about 14 kilometres (say $8\frac{3}{4}$ miles, as compared with the 20 miles or so between Calais and Dover), soundings along this line have indicated depths of more than 600 metres (2000 feet). This means that the lowest level of the tunnel might have to be taken to 650 metres below sea-level—a somewhat formidable depth. There are alternative locations to the westward where the depths are more moderate (400 metres or so), but these entail a longer underwater length of tunnel, while on the other hand they are susceptible of easier inclines and involve very little more total length between openings. Commenting on these alternative locations, the author points out certain approximate limits within which the physical conditions should be studied so as to arrive at a line which, without exceeding a length of 30 or 32 kilometres, would be best adapted to traffic requirements. It is impossible in a brief notice to touch upon the many points of great interest in the treatise, which, apart from some few paragraphs of rhetorical advocacy, is a seriously reasoned and careful analytical investigation of the evidence available. The volume has an introduction by General Damaso Berenguer. B. C.

A WAYFARER IN CENTRAL GERMANY. By MALCOLM LETTS. *London: Methuen & Co.* 1931. 8 × 5 *inches;* xx + 236 *pages; illustrations and maps.* 7s 6d

The author, who has already described his wayfaring experiences on the Rhine, now acts as guide for English visitors to a zone of Germany stretching from Cleve and Calcar in the west to Magdeburg, Zerbst, and Naumburg in the east, including the Harz mountains and towns and the Weser Valley; and from Brunswick in the north to Eisenach, Erfurt, Weimar, and Jena, bordering the Thuringian Forest, in the south. Obviously for a single holiday a tourist must select from this comprehensive programme, and an appendix containing suggestions for tours, both with and without a car, is useful to this end. The special lure is assuredly the small towns—"die Romantik der Kleinstadt"—often peacefully isolated, with their wealth of half-timbered and wood-carved houses, such as Höxter in the Weser Valley. Mr. Letts wisely encourages the Englishman to forsake the beaten track and see charming survivals of mediaevalism, to the proper preservation and exploitation of which the Germans are now fully alive. One could wish that in many parts of England the needs of students and travellers were equally well catered for. These pages make a pleasant compound of landscape, history, art, and architecture. At Calcar "the church is a veritable museum of wood-carving," and contains a High Altar, a masterpiece of woodcraft, completed in 1500. St. Victor's Church at Xanten is one of Germany's finest Gothic churches. The author gives us the quintessence of towns, some of them quite delightful but little known, like Münster, Soest, Hameln, Höxter, Brunswick, Wordsworth's Goslar, with its Frankenberger Plan and imperial palace, Hildesheim, Naumburg, Jena, Weimar, and Marburg; and of the Harz, decried in the

early nineteenth century, with its glorious panoramas. He is a well-equipped and sympathetic guide, whose descriptions whet the appetite. He is however not innocent of the use of an unrelated participle, *e.g.* in "Looking down from the window of the hotel, the modern world . . . seems very far away"; or of an unrelated gerund, *e.g.* in "After exploring the town, it is a good plan to climb, etc." In good writers such solecisms should have no place. S. E. W.

GEORGIAN ENGLAND: A survey of social life, trades, industries and art from 1700 to 1820. By A. E. RICHARDSON. *London: Batsford* 1931. 9×6 *inches;* viii+202 *pages; and illustrations.* 21*s*

Mr. Richardson's book is evidence of the revived interest in the eighteenth century and its works. The Georgian period was the climax of the traditional England, an England barely touched by industrialism, ruled by a close oligarchy of landowners, hardly awake to its destiny overseas, and bound by powerful conventions in art and literature. To modern eyes, Englishmen of that day will appear insensitive, self-sufficient, high-spirited, and not a little gross: the qualities of that representative figure, Samuel Johnson. With all respect for Mr. Richardson's enthusiasm, it is doubtful whether they had such a good time. The junketings depicted by contemporary artists were probably of rare occurrence in the lives of ordinary people. The conditions under which they lived are sufficiently testified to by the exceedingly high death rate. Yet though the eighteenth century had more than most a distinctive character, there were undercurrents to indicate approaching change: the romantic movement was under way before the close, and the humanitarian spirit, after reforming prisons and establishing Sunday schools, had gained sufficient strength to impose the abolition of slavery upon a reluctant European Congress in 1815.

These conflicting tendencies are brought out in the opening chapter, but on passing to describe the arts and crafts in turn, Mr. Richardson is liable, except on his own subject, architecture, to fall into the mere enumeration of facts. The reasons behind changes in technique might have received further explanation, though the chapters on architecture, interior decoration and furniture are not open to this objection. The remarks upon farming make no reference to the introduction of the turnip, to the four-course rotation of crops, or to the work of Jethro Tull or Coke of Holkham. The statement that even then England was a nation of town-dwellers seems likely to raise misconceptions.

With the help of the many excellent illustrations the reader may trace the development from the unwieldy, florid mansions built under Roman influences to the simpler designs resulting from study of Greek models, and from the necessity of building houses still outwardly imposing, yet in which it was possible to live comfortably. The illustrations also drive home the great distinction between the eighteenth and twentieth centuries—the existence in the former of a community of craftsmen able to express their individuality within the bounds of universally accepted conventions. G. R. C.

THE ARCHAEOLOGY OF BERKSHIRE. By HAROLD PEAKE. *London: Methuen & Co.* 1931. 8×5 *inches;* xii+260 *pages; illustrations and maps.* 10*s* 6*d*

Geographers will welcome an archaeological handbook which contains so many sketch-maps, even though they may sometimes criticize their execution. The author was one of the first to introduce into the archaeological world those ideas concerning distribution and the influence of environment which now hold the field. The book itself is a monument of patient research; it is original in conception, logical in arrangement, but deficient in some important respects. Never-

theless it is an invaluable handbook, by far the best book on Berkshire that has been published. The arrangement is chronological; more attention is given to finds than to sites; and although the Archaeological Gazetteer at the end is a model of completeness and ease of reference, the text seems, to the reviewer, too much like a mere expansion of the gazetteer. It is of course much more than this, but it is dry reading and, we think, unnecessarily so. There is too much of the museum and library atmosphere, and not enough of the open downs for which Berkshire is famous.

We make these criticisms because we are judging these handbooks by the high standard they have already set for themselves. There is nothing else quite like them in this country, though there are many abroad, especially in Germany. We can heartily and conscientiously recommend this book to all who wish to know more about Berkshire history and archaeology, provided they read it critically. O. G. S. C.

STUDIES IN GREEK SCENERY, LEGEND AND HISTORY. By Sir J. G. FRAZER. *London: Macmillan & Co.* 1931. 8×5 *inches;* x+420 *pages.* 8*s* 6*d*

This book was first published under another title in 1900, but is made up of material which was not even then new. It comprises the introduction to Sir James Frazer's edition of Pausanias, various descriptions of parts of Greece and of incidents in Greek history extracted from the commentary of the same work, and the article on Pericles in the ninth edition of the *Encyclopaedia Britannica.*

The account of Pausanias, though presented without the apparatus of references which belongs to it, preserves the character of an introduction to a learned edition. The life, work, objects, methods, accuracy, honesty, sources, antecedents, and style of Pausanias are in turn discussed, and he is vindicated from the attacks of those carping professors from whom he shrank in his lifetime, but could not escape after his death. The most interesting point raised is that of the nature of Pausanias's work. If he was a geographer at all he was one by mistake: by inclination and by profession he was an antiquary, with an especial interest in religious matters. As such he was writing a guide book to Greece, already a country of historic sites and monuments; and the *Description* which we have is no more a work of geography than is Baedeker. A superficially geographical appearance is imparted to the work by its topographical arrangement and observation of routes. But tourists must travel as well as explorers, and Pausanias gives hardly more information than will help them to get from one centre to the next. Although later in his work he begins to take some notice of the nature and present state of the country, he regards this as strictly an irrelevancy. Pausanias, like most of the ancients, displays little interest in natural scenery, but his editor has provided a series of brief descriptions of the various sites, and also of the remains at present to be seen which Pausanias did not describe, such as fortifications. They are only a page or two long each, but just provide that topographic background and that pictorial embellishment which a modern reader expects. Here indeed he may find both a little too concentrated, for the descriptions, which were written to illuminate the course of an antiquarian commentary, now follow each other with the rapidity of successive pictures on a film.

Where he touches on history, Sir James Frazer accepts fairly orthodox views, and is therefore at variance with many modern authorities. But the questions of Periclean politics are always in dispute; and this essay, as befits it, takes what may be called a standard view, and gives Pericles himself credit for as much as possible, somewhat to the detriment of his various rivals; for a panegyrist of Pericles must necessarily be curt with Cimon, Thucydides, and Sparta.

D. A. G. H.

ASIA

THE JAPANESE POPULATION PROBLEM: the Coming Crisis. By W. R. CROCKER. *London: George Allen and Unwin* 1931. 9×6 *inches;* 240 *pages.* 10*s* 6*d*

This book is a sympathetic and learned account of the problems resulting from the continued large annual increase in the population of Japan proper. It contains a careful analysis of the general conditions affecting the solution of the problems. The headings of the chapters will serve to give an idea of the way in which the author deals with these very intricate matters. Thus we have chapters on International Relations in the Pacific, on The Japanese Background, the Pressure of Numbers in Japan, The Future Population, On Growing their own Food, on Industrialization, on Relief through Emigration, and an important final chapter of Conclusions. The author has evidently taken great pains to acquire correct information and presents it in a clear and telling way. Though the book is relatively small, it contains a mass of useful facts, some of which must have involved much labour to obtain. There is a bibliography of some 320 books, papers, and reports relating to the subject. There is no mathematics, and perhaps this is a good thing. In other respects the book might serve as a kind of introduction to the study of the whole subject of population, as it deals with many aspects of this many-sided science.

The author looks upon the pressure of population as the basic factor in the foreign politics of the Pacific region, and he points out that, if we include India, the Asiatic side of the Pacific touches lands which are inhabited by more than half the human race. He indicates the outward pressure of the Chinese in Siberia, Philippines, Hawaii, Tahiti, Malaya, and elsewhere; but this pressure has no international implications. It is very different with Japan. In Japan proper "humanity is pent up in thick density on the flats and valley bottoms, and the rest of the country is left over to the wilderness of the forest-clad ranges." In Japan practically all the available arable land is made use of. The country is a series of typical Pacific islands, and the mountains are too steep for cultivation. Add to this, that the population has doubled itself in the fifty years between 1878 and 1928; that the birth-rate is over 34 per 1000; that the land is subjected to most intensive cultivation; that the people are capable, hard-working, and assimilative of Western ideas; that the Government is efficient and fully alive to the difficulties of the situation; and you have some of the elements of the problem, which very much engages public attention in Japan to-day. As a Minister of Finance has said, "The fundamental solution of the Food versus Population Problem is the one grand aim of the present Government's economic policy."

The author gives us a definition of over-population, which he describes as a condition of affairs in which a pronounced increase in numbers is accompanied by a continuous decline in the standard of living, there being no other forces that can be singled out as explaining the decline. Judged thus, it is doubtful if Japan can be said to suffer, at the present time, from over-population, at least, not to any considerable extent. But a glance at the probable future shows a different state of things, and the author carries us through a difficult and interesting study of birth-rates and age-groups, showing that within the next generation a large addition to the population is certain, "probably not less than 15 to 20 million," perhaps more. "If 60 million inhabitants have strained Japanese agriculture into Diminishing Returns, how will it fare when the 80 millions have arrived?" And here we may remark that the latest census—taken in October 1930—gave the population of Japan proper as 64·447 millions.

Population pressure is not a new experience in Japan, but for a century and a

half the numbers remained almost constant. Now the state of affairs is very different. The way of escape is by a reduced birth-rate, by industrialization, and by emigration. An important chapter deals with industrialization. It is stated that the numbers employed in Agriculture, Industry, and Commerce are as 55, 20, and 12. A good deal of space is devoted to a description of silk-culture, cotton manufactures, and other industries. It is clear that Japan must increasingly become a manufacturing nation, though the situation is not free from difficulties, largely from the relative lack of coal and iron.

There is an important discussion of the relief that might be expected from emigration. There is often a tendency for a population to fill up to a certain pressure, whether there is emigration or not; but not in every case. There are conditions in which emigration may be expected to afford some relief. The Japanese make good emigrants and, contrary to the opinion sometimes expressed, can endure extremes of heat and cold. The author seems to look to possible migration to Borneo, New Guinea, the South Pacific Islands, and Brazil. He even includes Northern Australia. He thinks that the "drawing off" of some 50,000 to 100,000 persons each year, under an emigration scheme, might ensure the stability of Japanese society until the time comes when the population becomes stationary. It is probably unwise to lay much stress on speculations of this kind. C. F. C.

REISEN VAN NICOLAUS DE GRAAFF (1639–1687). Edited by J. C. M. WARNSINCK. *The Hague: Martinus Nijhoff* 1930. [Vol. XXXIII of the Linschoten Vereeniging's publications.] 10×6 *inches;* xlii+230 *pages; illustrations and maps.* 30 *fl.*

Readers of this scholarly work will have every reason to be grateful to Captain S. P. L'Honoré Naber for his importuning Captain Warnsinck, of the Royal Netherlands Navy, to undertake the editing of De Graaff's bulky but interesting tome. Nicolaus de Graaff was a man who rivalled even such doughty voyagers as Marco Polo and Fernaõ Mendez Pinto in the scope and extent of his wanderings. In the course of fifty years of practically ceaseless travelling he visited the East Indies five times, South America and Greenland once, and the Levant twice, whilst in the intervals he fought under De Ruyter and his comrades against the Swedes, Turks, English, and Portuguese. He is equally at home whether describing a Catholic procession in Madrid, the four days' fight of June 1666, or the wiles of Dutch smugglers in Bengal or Japan.

Even if his plain and straightforward narrative lacks something of the classical grace of Pinto's stately Lusitanian prose, yet he makes up in reliability for any defects in his literary style, whilst his description of the habits of the Batavian ladies in the *Oost-Indische Spiegel* should arouse envy in some of the most scurrilous of our modern writers.

As a picture of the golden age of Jan Compagnie in Asia, this book is unrivalled, and De Graaff clearly exposes to us the extent and influence of the enormous private trade which even then was rapidly undermining the imposing fabric of the Hollander's oriental Empire—a dominion which then stretched from the Cape of Good Hope to Japan. From a geographical point of view also the book teems with interesting descriptions and observations, for De Graaff was a careful and painstaking observer.

It is impossible in a limited space to indicate all the matters worthy of note in this book, but mention must be made of De Graaff's adventurous climb up Table Mountain in 1678. On this occasion he calculated the height of Table Mountain as the equivalent of 1123 metres. Valentijn, who, as the editor points out, had countless times utilized De Graaff's work without acknowledgment in

his celebrated 'Old and New East India,' gives the correct (*sic*) height as the equivalent of 6996 metres, and sneers at De Graaff's estimate in a most unclerical manner. Since the real height is 1092 metres it will be seen that De Graaff's estimate was—for the time—a wonderfully accurate calculation.

Apart from the interesting story he has to tell, De Graaff appears to have been a very likeable man, and we accompany him on his travels with a right good will, feeling that he had surely earned his rest when he settled down in his native Hoorn after half a century's Odyssey. As was to be expected from the present editor and publishers the book is very well edited—the annotation being kept strictly within bounds—and published in a worthy manner at a reasonable price.

C. R. B.

AN ECONOMIC AND COMMERCIAL GEOGRAPHY OF INDIA. By B. B. MUKHERJEE. *Calcutta: Thacker, Spink & Co.* [1931]. (*London: W. Thacker and Co.*) 9×5 *inches;* vii+168 *pages. Rs.*3 *As.*12 (6*s* 2*d*)

Blue books, gazetteers, and special memoirs provide a mine of information on the commercial products of India and the economic questions arising out of their production and distribution, and there is need for a handbook which will provide the student and the business man with an accurate survey of the subject based on the ample material available. Sir George Watt's 'Commercial Products of India' is, of course, a classic; but it is a dictionary, not a treatise; and, as it was published in 1908, it now requires revision. The book under review, though it contains much interesting matter, can hardly be said to be the book that is wanted.

Apart from mere slips, such as "Bihar" for "Berar," on p. 36, there are loose statements like "The pine, a Himalayan tree, is in wide demand for making railway sleepers." There are several pines, widely different in habitat and characteristics. There are also mistakes that seem to show some lack of accurate knowledge: such as "Teak is grown on the Himalayan slopes"; "The Mysore and Hyderabad States and the Chittagong Division of Bengal receive more than 10 inches" of rain "in November and December"; "the hottest part of India, the district round Nagpur, records an even higher temperature" (than 90° and upwards) "in August."

The list of timbers in the chapter on Forests is incomplete. There is no mention of the so-called Indian laurel (*Terminalia tomentosa*) or of *padauk*, of which such excellent use has been made in the new India House. Nor is *pyinkado*, after teak the most important Burmese timber, mentioned. The printing should have been more carefully supervised. Subheadings are not consistently used, and are sometimes omitted where obviously required. "Pottery" comes under "House-building Materials." There is no index.

W. H. A. W.

AFRICA

JUNGLE WAYS. By W. B. SEABROOK. *London: Harrap* 1931. 9×6 *inches;* 280 *pages; illustrations and sketch-map.* 10*s* 6*d*

The American author is unusually frank, not only in expression but in self-revelation. This frankness makes unnecessary all speculation as to the reason for the journey undertaken through the Ivory Coast and the Haute Volta from Grand Bassam to Timbuktu and back with, during a great part of it, the most intimate companionship of a native sorceress. Curiosity, we are told, was the great incentive: curiosity (to judge by the 280 pages) as to certain native customs and ceremonies (of both of which there are many pornographic descriptions), cannibals, and mystic religious beliefs. With apparently no previous personal knowledge of West Africa, the peoples, or their languages, the author gives his

readers the benefit of his interpretations of long conversations (carried on through a native interpreter) on "abstract doctrines" and such deep subjects as the "kinetic spark of life."

The outcome of Part II, which is devoted to cannibals, is that the author proved to his own satisfaction that human flesh tasted like veal, and, having eaten it, boasted "a sense of pride, also, in having carried something through to a finish. And a long-standing personal curiosity satisfied at last." Curiosity carried indeed to "crazy extremes." To curiosity is added optimism, since we read that "some millions of people will sooner or later read these lines in one language or another." But by binding them all together at the end, the publishers have thoughtfully arranged that the thirty-two photographs, which to the ordinary reader will probably prove the most interesting part of the book, may be looked at without interruption from the text.

The most pleasing chapters are on Timbuktu, now so often visited by tourists, where the French Commandant gave some useful information, and which was described under the influence of Pére Dupuis-Yakouba "the greatest living authority on native languages and customs in French West Africa." The strange cliff-dwellings of the people in the Habbé country south of Timbuktu and the photographs of Ireli are curiously interesting. E. W. N.

A VAGABOND IN BARBARY. By HARRY L. FOSTER. *London: John Lane* 1930. 8×5 *inches;* xii+308 *pages; illustrations and map.* 12*s* 6*d*

Every year, as the American author is careful to point out, hundreds of tourists of his own and other nationalities follow the same North African motor route through Morocco, Algeria, and Tunisia from Casablanca to Tunis, the Cie Générale Transatlantique having made the accomplishment of this journey both easy and comfortable. To those contemplating such a journey Mr. Foster's account is worth reading. He is able to tell them more perhaps than they will learn for themselves since by travelling in ordinary motor buses and second class by rail he saw more of native travellers than do those visitors who travel in more luxurious motor cars. Also though it describes all the "standard sites" 'A Vagabond in Barbary' is more than a guide book, for the author has read industriously the latest books on North African travel, and has adapted for his reader's use historical and political information.

After flying from Toulouse to Tangier Mr. Foster followed the North African route in late summer, when, to his loss, the ground had lost its spring carpet of brilliant wild flowers. How speedily the whole width of Morocco may now be covered we learn from the time-table given of a motor-bus service which announces the run of 646 kilometres from Casablanca, on the west coast, to Ujda, the border town in Algeria, to be possible (barring accidents) in twelve hours!

Casablanca, Meknes, Rabat, Mulai Idris, and Fez are described after more leisurely inspection than this through-run would have permitted, indeed, after sufficient time had been spent for the author to feel, as is true, that in Old Fez the inhabitants "admit the European visitor—and ignore him." Marrakesh, farther south on the edge of the Atlas Mountains, cast its usual spell, but did the author really see the famous tower of the twelfth-century Kutubiya Mosque, "ablaze with gaudy tiles"? The reviewer seems to remember it otherwise, and the author later states "To-day its glories have faded somewhat; only a few of the original tiles remain in place." And without wishing to be too critical, is "temple" a satisfactory word to substitute for "mosque"?

There comes just a breath of magic from that desert which lies beyond railhead, when the author describes his drive (still by car) through Beni Unif to Figig,

sometimes claimed to be the "largest oasis of the Sahara." Uncomfortable, we are told, was the short walking tour in Kabylia, but more off the beaten track, as was the nine-day camel journey from Biskra to Tozur, though even then the tourist route was not completely left behind. For the camel caravan was passed by the specially built Renault motor bus with its hoisting drum with metal cable for use when engulfed in sand, a different type of Renault evidently from the one in use at the same date on the Trans-Saharan route (one not followed by the author) southward from Algeria.

Without claiming in any way to be a tale of adventure this book is pleasant reading. E. W. N.

GAME ANIMALS OF THE SUDAN: THEIR HABITS AND DISTRIbution. By Captain H. C. BROCKLEHURST. *London: Gurney and Jackson* 1931. 9×6 *inches;* xx+170 *pages; illustrations and map.* 21*s*

This book, compiled by the Game Warden of the Sudan, is an excellent practical guide, and might well be included in the list of equipment which he recommends for African travel. It is clearly designed for the use of hunters. There is a brief description of each species of animal with a note on its horns, weight, height, localities where found, type of country frequented, character of spoor and other details of special interest to every visiting sportsman. It contains a series of golden rules for the novice, also a number of practical hints on bleaching skulls, softening skins, removing horns, making vital shots. The hunter in the Sudan will not go far wrong if he follows its excellent instructions and advice.

Nevertheless we regret the necessity for its publication. The Sudan is one of the few bits of unspoilt Africa. Wild life still abounds in it. The sportsman cannot there get his game easily. It is so immense, so dreary, contains such vast deserts and extensive swamps, that only those possessed of grit and enterprise can hope to penetrate its unexploited regions. We instinctively dislike every step that facilitates the opening of these remote fastnesses to the use of the modern rifle. Much as we admire Captain Brocklehurst's book, we only wish that it had been a volume of instructions for the photographer rather than for the collector of trophies. The former needs every encouragement possible; fortunately his numbers are slowly augmenting, and he is playing a steadily increasing part in checking the awful waste of life.

The elephant is at present a cause of much concern. It is reassuring to learn that it is still plentiful in many parts of the Sudan. Nevertheless, according to the reports of the Custom authorities, there has been exported during the last five years from the Sudan £117,966 worth of ivory directly and £216,478 worth in transit. One shudders at such figures, which may be taken to represent the slaughter of something like 13,000 elephants. The elephant is one of the slowest breeding animals on earth. It does not breed till it is thirty years old, and then produces one calf about every five years. How can it possibly hope to survive this terrific toll of wastage? It is gratifying to know that the few white rhinoceroses left are at last rigorously protected; but whether this energetic action comes too late only time can tell. We do not know if a wild stock so terribly reduced can be restored to a vigorous state.

The naturalist, as apart from the hunter, will also find some interesting facts in this book. For instance, it will rather surprise him to learn that the author has never known an unwounded buffalo make any attempt to attack, and still more, that lions inhabit waterless areas where they must obtain all the water necessary for their existence from the stomachs of the antelopes they kill. Above all, he will be pleased with the charming illustrations, and especially with certain of the coloured plates which are of the highest merit. R. W. G. H.

THE DARK CONTINENT: AFRICA, THE LANDSCAPE AND PEOPLE. By H. A. BERNATZIK. *London: "The Studio" Ltd.* [N.D.] 12×9 *inches;* xvi (*text*)+256 (*illustrations*) *pages.* 30*s*

This is a book of very beautiful photographs portraying the landscape and people of Africa. The whole continent comes under review, and only pictures of high merit have been included. Some of the landscapes are particularly charming. We see the rivers, swamps, mountains, lakes, forests, amongst them being such well-known attractions as Kilimanjaro, the Victoria Falls, and the giant vegetation on the slopes of Ruwenzori. Native types are profusely illustrated. Moreover, they are very true to life; there has been little or no posing of the subjects but a genuine attempt to show them as they are. Many native customs, modes of life, and ceremonials are illustrated, such as dress, ornaments, fetishes, burials, festivals, dances, hunting-operations, rock-carvings, and other works of art. It would be impossible to make a photographic record of Africa without introducing the wild animal life. Hence we have a series of fine bird photographs, especially ostriches, gannets, and penguins. The big game mammals also receive full attention, the pictures of the elephant, rhinoceros, hippopotamus, buffalo, giraffe, antelopes, and gazelles being particularly true to nature. Any one who turns over the pages of this volume will see all the most striking objects in Africa within the space of half an hour. R. W. G. H.

ZANZIBAR: Its History and its People. By W. H. INGRAMS. *London: H. F. and G. Witherby* 1931. 9×6 *inches;* 528 *pages; illustrations and sketch-maps.* 25*s*

The number of books on Zanzibar is not great, and thus the work under review is the more to be welcomed and appreciated as the author by his earlier publications on that once famous East African emporium has already qualified himself as a keen observer and conscientious chronicler during the eight years (1919–27) spent in the Government service of the Sultanate. He has produced a historical, anthropological, and ethnological survey which up to the present time was not available in one volume and which will be of the greatest value to those who want to make themselves acquainted with the fundamental conditions of one of the most charming British Protectorates.

Mr. Ingrams masters the history of Zanzibar well. He has carefully compiled the much-scattered material for the early history and does justice to the events of modern time. While recognizing the important part Said Bin Sultan has played in extending the dynasty of Oman over Zanzibar, where it rules to the present day, he might have been more liberal when dealing with the bibliography about this outstanding personality. The good services rendered to Zanzibar by a great number of British officials is rightly recognized. Names like Hamerton, Kirk, Rodd, Matthews, and last, but certainly not least, Hollis, are judged by their achievements, to the credit of the nation they represented with loyalty and distinction.

The main interest of the book lies in the anthropological and ethnological chapters. They offer a fulness of material not to be found in previous publications. What Ingrams says about the social life of the population, their language, their family and tribal organization, their customs and manners—to name but a few items—proves not only the thoroughness of his studies but also the high degree of his understanding of other creeds and races.

The statement made on p. 85 with reference to "the first crossing of the African continent by a European. This was achieved by a Genoese, called Leone Vivaldi, who crossed from west, reaching Mogadisho about the end of the eleventh century," calls for adjustment. It was about 1320 that Ser Leonis Vivaldi arrived at Magdasor by the way of Egypt, but could not proceed farther

owing to the dangerous state then prevailing on the mainland (cf. 'Le Navigazione Atlantiche, a cura di Rinaldo Caddeo.' Edizioni "Alpes" Milano, 1928, pp. 36–37). He had set out in search of his father and uncle, who both had sailed from Genoa in 1291 and were detained with their companions at the Senegal river by the natives, never to return (cf. 'L'Expedition Génoise des Frères Vivaldi à la découverte de la Route Maritime des Indes Orientales au XIII siècle.' Par M. d'Avezac. Paris 1859).

The Government of Zanzibar rendered possible by subsidy the publication of this well-produced work, and is to be congratulated for having done so. The book will hold its own as one of the most valuable yet written on Zanzibar.

R. S.-R.

NORTH AMERICA

NARRATIVES OF THE DISCOVERY OF AMERICA. Edited by A. W. LAWRENCE and JEAN YOUNG. *London: Jonathan Cape* 1931. 9×6 *inches;* xiv+300 *pages; maps.* 10*s* 6*d*

The book contains translations from the sagas which relate the Norse discovery of America; the Journal of the first voyage of Columbus; the letters of Pasqualigo and Soncino on John Cabot's first voyage; and parts of Columbus's letter to the Spanish Sovereigns dealing with his discovery of Trinidad and Venezuela on his third voyage. There are brief separate introductions to each of these transactions. For the Norse voyages the arrangement adopted by Mr. Gathorne-Hardy is followed, and his tentative identifications are embodied in a map. The text of the Journal of Columbus is a revision, by the editors, of S. Kettell's translation of 1827. Mr. Cecil Jane's recent version appeared too late to be used, but there is no mention of Sir Clements Markham's edition for the Hakluyt Society in 1893. Similarly, the two Cabot letters are presented as the editors' revision of [Rawdon] Brown's translations, to the neglect of the later and more authoritative versions in Dr. H. P. Biggar's 'Precursors of Jacques Cartier' and (for Soncino's letter) in Mr. A. B. Hinds's 'Calendar of State Papers, Milan.' Thus, among other questionable renderings, we find Pasqualigo speaking of "two islands to starboard," a phrase upon which much argument has turned, and which Biggar showed to be a mistranslation. The footnotes to the texts are numerous and informative, although they also include one or two assertions that are now discredited, as, for example, that the variation of the compass had not been noticed before 1492. This book is of no value to the critical student. The general reader may find it interesting, but would probably be glad of fuller editorial treatment of the problems which the narratives must suggest to his mind.

J. A. W.

EDWARD W. D. HOLWAY: a pioneer of the Canadian Alps. By HOWARD PALMER. *Minneapolis: University of Minnesota Press* 1931. 8×6 *inches;* xiv+82 *pages; illustrations and map.* $1.50

This slender volume is a tribute to the memory of the late Professor Holway by his climbing companion, Mr. H. Palmer, a past-President of the American Alpine Club. Of their principal joint feat, the first ascent of Mount Sir Sandford, Mr. Palmer has already given full accounts in the *Alpine Journal*, vol. 27, and the *Geogr. Journal*, vol. 39. This peak, the highest of the Selkirks, proved difficult of approach as well as of attack. Situated in the heart of a trackless and unexplored region, where horse transport was impossible, what is locally termed "pack-harness" had to be resorted to; that is, all provisions and supplies had to be carried on the shoulders of members of the party. Despite this difficulty a region

300 square miles in area was explored and mapped for the first time by these hardy pioneers.

Mr. Palmer's object has been to furnish at least a skeleton of Professor Holway's remarkable career as a mountain explorer. It began late: up to middle life Holway was a successful banker. It was not till the age of fifty that he threw up business and gave himself free scope for his natural tastes: botany and mountaineering. How strenuously, despite his years, he pursued the latter Mr. Palmer's record indicates. After some climbs in the Rockies Professor Holway concentrated his energies on the least explored portions of the Selkirks, where for sixteen years he continued to do valuable pioneer work. A list of his principal climbs and explorations testifies to their extent.

We incline to agree with his biographer when he writes: "Probably the most important contribution to this series of successes was the extremely light weight of the camping equipment." Pioneers who travel with all their household goods on their shoulders learn to do without gramophones! D. W. F.

CENTRAL AND SOUTH AMERICA

A YANKEE IN PATAGONIA. Edward Chace: "His thirty years there." By KATHERINE and ROBERT BARRETT. *Cambridge: W. Heffer & Sons, Ltd.* 1931. 9×6 *inches; 350 pages; frontispiece and two maps.* 12*s* 6*d*

FROM PANAMA TO PATAGONIA. By CHARLES W. TOWNSEND. *London: Witherby* 1931. 9×6 *inches; 224 pages; illustrations and sketch-map.* 12*s* 6*d*

The biography of Edward Chace will enable English readers to realize the gap which separates the Patagonia of to-day from the Patagonia of Darwin, Musters, and Hudson. The plains, over which a few hundred Telechues ranged at will, are now "wired" into sheep and cattle ranches, worked by a motley population representative of most races of the Earth, reacting to modern economic and labour influences. Chace turned his hand to whatever necessity compelled or whim prompted—as blacksmith, boundary rider, gold prospector. His experiences, blended with the empirical lore of a keen observer of nature, were well worth recording. It is not necessary for the enjoyment of the book to accept everything recorded as truth—though the total impression is convincing. Judged indeed by other writers purporting to depict cosmopolitan life on the frontiers of settlement, his restraint is noteworthy. The book will probably be most enjoyed if dipped into from time to time, for the detail is often confusing, where there is no definite thread of narrative running through the chapters, as in "On virgin range," an account of life on an estancia, and "Sheep drives and sheep dogs."

In the opening chapter the authors describe how they coaxed his story out of him. The account, with its psychological trimmings, has unconscious humour, and it would be amusing to know what Chace thought of it all. "We had asked him formally, before a stenographer, if he had ever heard any legends told down there, and he had answered 'None.'"

Mr. Townsend's account of his trip round the coasts of South America is much more conventional—it is, indeed, largely a collection of hints to tourists strung on a "slender historical thread." His interest appears to be birds, though he professes only an amateur's knowledge, and he occasionally interrupts his somewhat breathless recital to discourse upon them or other subjects of more geographical interest, such as the desert coast of Chile, the recent vagaries of the Humboldt current, or the guano islands. But in general his method is not unfairly represented by the following quotation: "Merida, founded in 1542 on the site of a Maya city, is an important centre of 70,000 inhabitants, and the capital of

Yucatan. The ship's company lunched at the Grand Hotel on the Plaza de Hidalgo." Some of his statements however are enlightening—for example, that Valparaiso is the only port on the west coast where steamers are berthed alongside wharves, and that motor-buses now run to the Iguazu falls. Had he allowed himself to dwell upon subjects which obviously attract him, his book would have been better reading, but then of course it would not have been the book he set out to write. G. R. C.

SPENCER'S LAST JOURNEY: being the journal of an expedition to Tierra del Fuego by the late Sir Baldwin Spencer; with a memoir. Edited by R. R. MARETT and T. K. PENNIMAN, with contributions by Sir JAMES FRAZER and H. BALFOUR. *Oxford: Clarendon Press* 1931. 9×6 *inches;* viii+154 *pages; illustrations and maps.* 12*s* 6*d*

This little book is a memorial of a very distinguished and accomplished man of science. Sir Baldwin Spencer was not only a well-known zoologist; he had gained for himself a foremost place in ethnology, was a clever artist, and took a keen interest in contemporary art; his artistic taste and knowledge were much appreciated in Australia. In his introduction Sir James Frazer gives an interesting survey of some of the remarkable investigations by Sir Baldwin on natives of various parts of Australia, and a sympathetic memoir is provided by Dr. R. R. Marett which adequately gives the main events of his scientific career and affords insight into his charming personality.

Against the advice of various friends, Spencer determined to investigate the Yaghan of the extreme south of South America. A good account of the physical anthropology of the Yaghan has been given by P. Hyades and J. Deniker ('Mission scientifique du Cap Horn, 1882–1883'; Paris 1891), and in 'Les anciens Patagons' by R. Verneau; Monaco, 1903. These authors also give some information about the material culture of the people and their stone implements, but practically nothing has been recorded concerning their sociology and socio-religious life. Spencer went to Tierra del Fuego with an unrivalled record of ethnographical field-work among the Australians in order to undertake the investigation of an equally backward, and in this case a degenerate, people, in the hope of filling a gap in our knowledge and of being able to compare very different and widely remote races of mankind. This gallant attempt was prematurely frustrated by his death from *angina pectoris*, when he had been only two months in the field.

The field notes that are here published show how wide were Spencer's interests and give an indication of what might have been expected from him if he had had sufficient time; but the natives appear to be a poor lot and apparently without much interest for the ethnographer. There are some geographical notes and several capital photographs of scenery. Mr. Henry Balfour gives an excellent illustrated account of the artifacts collected in Patagonia and Fuegia. The chronological list of Spencer's works illustrates his wide scientific attainments. A. C. H.

ROCK PAINTINGS OF NORTH-WEST CORDOBA. By G. A. GARDNER. *Oxford: Clarendon Press* 1931. 14×10 *inches;* xvi+148+xliv *pages; illustrations and maps.* 4 *guineas*

Few archaeological discoveries have excited more attention and interest than those of cave and rock paintings revealed in recent years in France and Spain. The realism and artistic talent they displayed were such as to arouse scepticism regarding their antiquity. Further study established beyond dispute that they were of palaeolithic age. Such scepticism was remarkable in view of the fact that

long before these discoveries it was known that similar drawings had been made in Australia and South Africa by existing primitive peoples of much the same level of culture as presumably were the prehistoric artists. One result of these researches is an increased interest in the art of uncivilized races. The age of the paintings being established, attention was concentrated on their significance and meaning. Considerable controversy has thus arisen, more especially about the motives that inspired the work, and to what extent they were of a magical nature.

The author of this admirable book makes a valuable contribution to the study of these problems, all the more interesting since it is the result of investigation in a quite different and distant part of the world. He here describes and lavishly illustrates with photographs and coloured plates the results of long and careful study of a series of rocks and shelters in Cordoba, one of the provinces of Argentina. Here lived before the Spanish invasion a tribe of native Indians known as the Comechingons, who, like so many others, were exterminated by the Spaniards, who first arrived in this part of the continent in the latter part of the sixteenth century. When Cabrera founded Cordoba in 1572 the tribe was estimated to number 40,000 warriors; by 1600 they were reduced to 8000, and 150 years later no more than 300 were left. The rock paintings described and illustrated were undoubtedly the work of these unfortunate Indians, and there can be little doubt that many, if not most of them, were executed before the advent of the Spaniards. The numerous paintings in one locality of Spanish horsemen show however that they must have practised the art to some extent after their arrival.

The figures, numbering something like a thousand, are classified in three groups, viz. Natural Objects, Geometrical Designs, and Incomprehensible Figures. Of Natural Objects human beings and animals are numerous. The presence of the former and their occurrence in groups afford a striking contrast to the cave paintings of France and Spain. But it is interesting to note that human figures observed in the rock paintings of Eastern Spain resemble those of Cordoba in being armed with bow and arrow, and in showing feathered head-dresses. Of the animals the llama figures most prominently. It is not merely represented by well-drawn examples, but also in groups. Of birds the condor is realistically shown with outstretched wings. The human figures are almost wholly restricted to two of the six localities explored. In one of them the figures are mostly European horsemen, and are realistically treated; in the other they are solely Indians, and the treatment is conventional. The absence of the horse except in this locality points to the greater part of the paintings being pre-Hispanic, and the author ingeniously accounts for the realistic drawings of the Spaniards which must have been made after the Indians had been harassed by them, as being the work of natives who had retired to a safe retreat where they put down their impressions, naturally keen, of their enemies. The locality where they are found favours this view. The colours employed are white, red, and black. No less than 86 per cent. are of one colour, and of these 65 per cent. are white. A combination of two colours is fairly common, but examples of three are extremely rare. There is hardly anything comparable to the polychromes of palaeolithic art.

The significance and meaning of the paintings is discussed at some length, and they raise very much the same questions that have been so much debated in connection with the art of the European caves. Were they merely the expression of an artistic instinct, or were they magical, or decorative, or commemorative of some event? It is impossible to form any definite conclusions on the question. More certainly can it be affirmed that they are the work of the Comechingons, executed chiefly before the arrival of the Spaniards, and that "their representa-

tion of their conquerors is one of the last remaining traces of these Indians as an independent people."

Lists of Comparative References and of Authors are given in an Appendix, and there is a useful index. E. A. P

AUSTRALASIA AND PACIFIC

HIDDEN WEALTH AND HIDING PEOPLE. By MICHAEL TERRY. *London: Putnam* [1931]. 9×6 *inches;* xvi+350 *pages; illustrations and maps.* 15*s*

This book owes its charm in the first place to the vividness with which the day-to-day life of a very modern type of explorer in the arid wilderness of Australia is described. The very primitiveness of this life itself, lived in constant shadowy touch with the still more primitive ways of the Aborigines lends it a kind of Crusoe-like romance; those who venture upon that life must needs be rough in a virile way, full of good comradeship and pluck in the face of dangers through attacks from treacherous natives or through lack of water.

This story of a journey through Australia gains additional interest however from several special features. Throughout it as a thread runs the lure of search for gold in the rocks of a no-man's land; the motor-lorries with which the expedition was conducted are shown battling with all sorts of difficulties, and their triumphs of endurance make a strong appeal to our pride in mechanical conquests; and the writer has managed to give intimate pictures of an elusive but wildly fascinating landscape. Neither the human nor the nature interest ever flags. This book is one for boys as well as for older people: the former will be captivated by the unending succession of adventure and the racy narrative; the latter, especially if they have travelled in the wide world, by the accurate observation of geographical detail and by the skilful record of the results. Mr. Terry shows that the desert has charms, when as in Northern Australia it contains a great variety of surface formations and is often broken by patches and stretches of vegetation. The eternal question is where drinkable water is to be found; and the haunting mystery of the North Australian sub-deserts lies as much in their hidden water-holes, known only to nomad "blacks" as in their reputed stores of hidden gold. E. W. S.

INSECTS OF SAMOA, AND OTHER SAMOAN TERRESTRIAL Arthropoda. By P. A. BUXTON. Part IX, fascicule 1. Description of the Environment. *London: British Museum* 1930. 10×7 *inches;* 32 *pages; illustrations and diagrams.* 2*s* 6*d*

This final fascicule of the British Museum publication on the 'Insects of Samoa' is of considerable interest to the geographer in that he will here find a clear and concise account of the islands, their geology, topography, climate, fauna and flora, and anthropology.

The islands are in about 14° S. latitude, and represent true oceanic conditions. They are either volcanic or coral structures, and hence it is not easy to give any account of the geological history. Buxton maintains that their fauna is oceanic, "and that neither the islands nor their flora are a remnant of a great land." They lie to the east of those Pacific islands which may be grouped as "continental." Topographically they are not all fully explored, but the volcanic islands are much dissected by torrents, and to traverse these islands is almost impossible except along the coastal flats or on the main central ridge. Villages and settlements are on the low ground near the sea. Savaii is the largest island (47 by 27 miles) and reaches a height of about 6000 feet. The western group form a Mandated Territory administered by New Zealand; the remainder are American.

The account of the climate is interesting: it need not be fully discussed here as the geographer will appreciate what is meant by the term "oceanic." But these reports are the work of naturalists and one or two points call for some notice. Buxton writes: "In the past we biologists have relied too much on the meteorologist; we have forgotten that he is studying the dynamics of the atmosphere, and if his facts do not meet our needs, then we must collect our own." Solar radiation is first discussed, but, because of lack of data, not as fully as the author would wish. Instruments were a difficulty: pyrheliometers alone being appropriate, but these are difficult to use and really belong to the observatory. Hence another instrument, a blackened bulb *in vacuo*, filled with absolute alcohol, was devised. This demonstrated that the total amount of radiant heat received varied with the seasons, and that when the sun was more or less vertical an hour of sunshine produced about twice as much distillate as it did in the opposite season.

Duration of sunlight, temperature, rainfall, humidity, and wind are all discussed, especially in their relation to biological problems—and it is this aspect that makes the report of more than usual interest to geographers.

The fauna of the islands is strictly "oceanic": except for bats there are no indigenous mammals, no amphibia, no freshwater fish. There seems little doubt that the fauna has come from the west, and it is related to that of Asia and Malaya as well as to that of Australia. The "oceanic" nature of the fauna is against the view that Samoa represents part of a former land-mass. The flora also is derived from the west, and bears out the contention stated above that Samoa is a true oceanic island. The report concludes with a short account of the people and of the effects of European penetration. The whole forms a useful document and will repay study. It is a neat "compendium" of the Geography of a little-known group of islands. J. A. S.

POLAR REGIONS

DIE WEISSE GRENZE: Abenteuer eines alten Seebären rund um den Polarkreis. By A. JACOBSEN. Edited by A. JANSSEN. *Leipzig: F. A. Brockhaus* 1931. 8 × 5 *inches;* 160 *pages; illustrations and maps. M.*2.80

Captain Jacobsen was a Norwegian seaman from near Tromsö who, like so many of his compatriots, got his early training in polar seas in hunting seal and walrus around Spitsbergen. Later in his life he had wider experiences, and in the employ of the famous Hagenbeck visited various parts of the world. His adventures are put together in this book in a series of short chapters. It is nothing more than a volume of experiences in out-of-the-way places, and has no particular geographical value, though the chapters on Sakhalin and Alaska are of interest. The illustrations are good and the maps adequate. The volume is one of the well-known Reisen und Abenteuer series, to which it does credit. R. N. R. B.

PHYSICAL AND BIOLOGICAL GEOGRAPHY

REPORT ON THE SCIENTIFIC RESULTS OF THE *MICHAEL SARS* North Atlantic Deep-Sea Expedition 1910. Vol. I. *Bergen Museum: John Grieg* [N.D.] 12 × 10 *inches;* 12 + 116 + 102 *pages; diagrams and maps*

The expedition of the *Michael Sars* in 1910, which was financed by Sir John Murray and the Norwegian Government and directed by Sir John Murray and Dr. Johan Hjort, worked from Ireland to Gibraltar and the Canary Islands, then westward to Newfoundland *via* the edge of the Sargasso Sea and finally home across the North Atlantic, with a visit to the waters between Rockall and the Faeroes. A general account of the work, with digressions in various aspects of

oceanography, was published in 1912 ('The Depths of the Ocean,' J. Murray and J. Hjort), but the appearance of the scientific memoirs has been long delayed. They are now being published in English under the auspices of the Bergen Museum. The present volume contains two papers, of which the first, by Mr. J. Chumley, is on the deposits. The chief discoveries were the extension of the globigerine ooze area of the North Atlantic nearer the British coasts to the south and north of Ireland and to the north of the Rockall Bank and also the location of globigerine and pteropod oozes near the Canary Islands. Several of the samples showed distinct stratification with globigerine ooze lying above red clay. The second and longer paper, which deals with physical oceanography, is by Dr. B. Helland-Hansen. Much of it has appeared already in preliminary reports or in sectional papers, but the long delay in producing the full report has allowed certain later work to be taken into account. As an appendix to the discussion of results the observations are printed in full and there are several charts and sections. Among the many matters of general importance discussed is the heating of sea-water. The absorption of radiation from the sun causes a heating of the surface to such an extent that the topmost metre would rise in temperature 2° or 3° C. a day were it not for the lowering of the temperature by evaporation and re-radiation. Wave motion moreover causes the higher temperatures of the surface to be reduced. At greater depths rise in temperature by radiation from the sun is slight. At a depth of 50 metres the temperature rises about 0·004° C. a day during summer from radiation. But this accession of heat goes on throughout the year and deep water loses heat only if it comes to the surface or by convection processes. Dr. Helland-Hansen also reaches the paradoxical conclusion that water masses below the surface layers are the more protected against heating by conduction the higher the temperature of the surface is. These and many other matters are fully discussed, which makes the volume a valuable contribution to physical oceanography. R. N. R. B.

THE GOLD RESOURCES OF THE WORLD: an inquiry made upon the Initiation of the Organizing Committee of the XV International Geological Congress, South Africa, 1929. With a Summary by A. C. SUTHERLAND. *Pretoria: Bureau of the Congress* 1930. 11×8 *inches;* xiv+458 *pages; illustrations and maps.*

The meetings of the International Geology Congress have frequently been taken as the occasion for the publication of a work on the world resources of some mineral of especial interest to the country visited. Some of the previous works thus issued, such as those on the Resources of Iron Ore, Coal, and Pyrites (issued in connection with the meeting in Spain), are standard works of reference. A corresponding work on the Gold Resources of the world has been compiled in connection with the Congress held at Pretoria in 1929. The subject presents special difficulties owing to the great variation in gold ores and the different conditions of gold mining. The volume includes reports from forty-nine countries, from many of which the gold yield is now nothing, or is negligible, and may be only of historic interest, such as Great Britain, Germany, Austria, France, and the Dutch East Indies. Some of the countries omitted from the volume are more important as regards gold yield than some of those included. From some of the countries fuller and more up-to-date information is available elsewhere.

One difficulty with such a book is the different ways in which the returns are compiled, and it would have added much to its usefulness if tables could have been prepared summarizing the returns in a form more easy of comparison. The introductory summary by Mr. A. C. Sutherland is a useful synopsis; but the

returns in it are tabulated in ounces, in grains or kilograms of gold, in value in pounds or dollars, in pennyweights per ton of ore, or of tons of ore of which the value may or may not be given, or as a bye-product of unstated amounts in copper or lead-zinc ores. In a cosmopolitan compilation it is difficult to avoid misprints, which are numerous and some of them puzzling, such as the statement in reference to the greatest mine in Southern Rhodesia that one stage of the ore deposition was "reopening of the fissure, deposition of the quartz in the gold and stibnite" (p. 360); or (p. 61) a table of twenty years' gold production in Brazil without stating what values the figures are intended to represent; the statement that the thickness of the Witwatersrand Formation is 85,000 feet (p. 325) is difficult to reconcile with the table on the opposite page giving thicknesses that amount to the more probable total of 23,885 feet.

The reports are on different lines; in some cases the authority, in apparent despair at the outlook for mining in the country, devotes most space to the genesis of the ores or the geology of the field, and less to statistics; some chapters, in the absence of any known ore, give an interesting contribution to the prehistoric mining, such as Mr. Hallissy's report on the Gold Resources of the Irish Free State, or an account of occurrences of little economic importance, such as Dr. H. Beck's description of the gold veins of the Hohe Tauern. Dr. M. Palfy, in his excellent account of the Hungarian mines, deplores the lack of information since 1917 about those in the Hungarian Erzgeberge now in Czechoslovakia, or about those in Transylvania that have been transferred to Romania.

The most important known gold reserves in the world at present are in the Transvaal. Dr. Rogers gives a clear short account of the geological structure of the Witwatersrand field, and it is followed by an instructive estimate of the reserves by H. Pirow; he states that the field may be expected to yield another £1000,000,000 of gold. The United States yielded in 1927 over 2 million ozs. of gold; its highest output, 4·8 million ozs., was in 1908. The Homestake Mine, in Dakota, with its huge bodies of low-grade ore, is expected to maintain its yield for many years. The chapter on Canada by H. C. Cooke and W. A. Johnston is the fullest in the volume. The yield of Canada has greatly increased owing to the modern discovery of the three great mines of the Porcupine district of Ontario, and there is an interesting statement of the geological structure of these mines. The authors are more optimistic as to the contents of the saddle-lodes of Nova Scotia than some mining authorities who have examined the field.

One of the most valuable reports is that on the Russian fields, including those in Asia, by Professor D. Muskhetov, whose name is omitted from the List of Contents on p. x: their yield up to 1927 (p. 307) has been 2,752,154 kilograms of gold. The report on the gold yield from the Belgian Congo, which is mainly from placer deposits, is contributed by the Belgian Geological Service, and contains a useful sketch-map and bibliography. No information is given as to the state of gold-mining enterprise in Kenya Colony, Uganda, or Tanganyika Territory; a lucid synopsis of the gold deposits of the Gold Coast is given by Sir Albert Kitson. Dr. Fermor contributes a brief account of the Indian goldfields, with a section through the Mysore Mines showing the shoots as worked up to 1922. There is no report from China, Siam, Persia, or Turkey. The accounts from Australia indicate the decline in its mining; the output from Victoria is now small in view of its total gold yield of £302,000,000. The only state from which gold mining on a scale of world importance is expected is Western Australia, on which there is an instructive chapter by T. Blatchford; some large mines in the northern extension of the fields are being opened in the hope of working large bodies of difficult and low-grade ore. A valuable report of F. R. Feldtmann summarizes the present knowledge of the complex ores of the Kalgoorlie field.

The contributions are in nearly all cases from the Director of the National Geological Survey: the chapter on New Guinea does not give the author's name. The volume will be of service from its mass of official information as a record of the condition of the goldfields of the world in 1928 and their prospects of development. The information would have been of still more use if the volume had been provided with an index.

SEDIMENTARY PETROGRAPHY. (Second, revised and complete Edition.) By HENRY B. MILNER. *London: Thomas Murby & Co.* 1929. 8×5 *inches;* xxii+514 *pages; illustrations and diagrams.* 21*s*

"The cult of the detrital mineral," says Mr. Milner, "is well worth following," and in this new edition of his well-known book he supplies not only the stimulus of enthusiasm to take his advice, but ample and practical guidance in the study of detrital deposits. The book contains, like its predecessor, much valuable information on laboratory methods of sediment analysis and the characteristics of sedimentary minerals, clearly written and practically useful to students or research workers. A large new section is devoted to the study of consolidated sediments, with the same bias that is discernible throughout the greater part of the book towards the technique of oil-geology. For the geomorphologist, the most interesting chapters are those concerned with palaeogeographical problems, and the study of soils. The author approaches these problems from the point of view of mineral content as a guide to place of origin, giving examples in which the tracing of sedimentary minerals to their sources in parent rocks has thrown considerable light on such things as current and river directions in previous geological periods. A fascinating line of research is thus opened up, for those sufficiently experienced in the technique of the subject, in the elucidation of geomorphological problems. There are numerous cross-references, unfortunately occasionally misprinted, a great number of diagrams and plates, and a good index and bibliography. For the practical geomorphologist this should be an invaluable work of reference.

M. S. W.

OUTLINES OF HISTORICAL GEOLOGY. By CHARLES SCHUCHERT. Second edition. *New York: John Wiley & Sons* (*London: Chapman and Hall*) 1931. 9×6 *inches;* vi+348 *pages; illustrations and maps.* 15*s*

On both sides of the Atlantic Professor Schuchert's 'Historical Geology' and the abridgment from which the present edition has developed have already become deservedly popular. Stimulated by this success, and by his own indefatigable researches into the problems of Earth history, Professor Schuchert has now produced what is in many respects a new book. The continuity of his story of the unfolding of life is greatly enhanced by a marked improvement in arrangement. The necessary details of modern plants and animals which were formerly distributed at intervals through the text are now all brought together in two early chapters. Considerable attention is paid to the history of investigation; to evolution as the keynote of geological chronology; and to the palaeogeographical method of approach. This last feature, indeed, gives the book the character of an original contribution to North American stratigraphy, for all the palaeogeographical maps have been redrawn in accordance with the latest evidence available. They are dated 1930. Many other new illustrations have been incorporated, and there is now at least one to every pair of pages. The photographs reproduced are beautiful in themselves as well as geologically effective, and the book, which bears all the marks of having been a labour of love, is probably the most richly illustrated geological text yet issued. It is, moreover, written in a straightforward style, adapted to the orderly progression of the theme from the origin of the Earth

to the cultures of Neolithic man. It is refreshingly free from pedantry and undue technicalities on the one hand and from the purple patches of more "popular" books on the other. Although the book will necessarily make its greatest appeal to American students, it will repay study by British readers. Well-selected suggestions for further reading are given and a copious index is provided. The book, which is also obtainable bound in one volume with Longwell's 'Outlines of Physical Geology,' has been admirably produced, and author and publishers may feel justly proud. A. H.

ECONOMIC AND HISTORICAL GEOGRAPHY

OLD CIVILIZATIONS OF THE NEW WORLD. By A. HYATT VERRILL. *London: Williams and Norgate.* [N.D.] 9×6 *inches;* viii+394 *pages; illustrations.* 21*s*

In this volume the author has attempted to cover the vast field of ancient civilizations in the whole of the New World, and necessarily gives no more than a sketchy account of such divergent cultures as those of the Pueblo races, and of the Maya, Aztec, Chibcha, and Inca. Mr. Verrill discusses the origin of man in America—one of the most disputed problems of anthropology—and the vexed questions of the mound-builders of North America; the relative ages of American civilizations forms the subject of another chapter. Space is given to an informative résumé of the results of work by many investigators of the calendrical system and hieroglyphs of the Maya of Central America and Yucatan. As regards South America, the author surveys the work of archaeologists in what is now Peru, giving an account of Chimu culture, and touching on the fine work of the Nasca region, discovered in recent years, as well as evidences of civilization from other pre-Inca sites on the west coast of South America.

A useful bibliography is included; the index is scant; and the acknowledgment of many of the illustrations is incorrect. T. A. J.

GEOPOLITIK: DIE LEHRE VOM STAAT ALS LEBEWESEN. By RICHARD HENNIG. 2nd ed. *Leipzig: Teubner* 1931. 9×6 *inches;* viii+396 *pages; maps and diagrams. M.*18

GEOGRAPHISCHE GRUNDLAGEN DER GESCHICHTE (Geschichte der führenden Völker, 2). By HUGO HASSINGER. *Freiburg i. B.: Herder* 1931. 9×6 *inches;* xii+332 *pages; maps. M.*10.50

DAS POLITISCHE ERDBILD DER GEGENWART. By OTTO MAULL. (Sammlung Göschen, No. 1030.) *Berlin: W. de Gruyter* 1931. 6×4 *inches;* 160 *pages; maps. M.*2

Professor Hennig's first task is to differentiate between political geography and the recently coined term "geopolitics." The former he regards as purely descriptive, and in the main historical; the rôle he assigns to "geopolitics" is more "dynamic" and philosophic—the estimation of the strength and direction of geographical, economic, and political influences in the past, and their probable development in the future. Whether this treatment is so new or so valuable will probably be doubted by many after reading his book. Its foundation is the conception, by now familiar from other German works, of the state as an organism—the union of a section of humanity with a portion of the Earth's surface. This may or may not be a sound or an enlightening analogy, but its discussion is unnecessary here—for Professor Hennig's real concern is with the relations of the various states to their neighbours, and their struggle for a share in world commerce and politics, in short, for "a place in the sun." First however he takes

his readers over the familiar ground of the influence of climate, soil, and position upon the development of states, and classifies minutely the various kinds of boundaries. He then examines the question of over-population, and the "empty" areas capable of relieving it, in conjunction with the "revolt of the Orient" against the dominance of the Western European nations. This leads on to a consideration of modern colonial methods.

His themes throughout are plentifully, and sometimes confusingly, illustrated by numerous citations from all ages and countries. These would carry greater conviction if they were not so obviously selected to discredit the post-war settlement of Europe and the present international régime. Economic, ethnographic, and strategic considerations must often conflict in boundary making, so that no universally acceptable solution can be found. In arguing the case of certain powers, the conception of the state as an organism can be used as a handy weapon, but it is just here that it breaks down—for it is surely a strange organism which defies an absolute determination of its limits. As for the later chapters, they degenerate into an embittered attack upon all and sundry—France's record as a colonizing power, England's rule in India, the United States' Caribbean policy, the mandatory system, and so forth. From it all emerges apparently but three positive suggestions, the conferring upon the peoples of a mandate the right to elect for a short and definite period the power to which the mandate is to be entrusted; the general recognition of an economic "Monroe doctrine"; and improved treatment of subject peoples. Similarly, the terms "people," "nation," and "state" are discussed with intent to ridicule self-determination as embodied in the present European state system. Pressing though the problems which require adjustment in the world may be, it is difficult to escape the conviction that there is little guidance to be gained from a pseudo-science, however imposingly garbed in grandiloquent phraseology.

It is a relief to turn to the objective and geographical study of Professor Hassinger. Designed as an introduction to a cooperative history in several volumes, it is not concerned with purely historical material, but with the environment amid which the leading nations have played out their histories—with the natural resources upon which their power has rested, and the consequent strength, or weakness, in their struggle for dominion. Professor Hassinger recognizes no "geographical compulsion": these resources are used or neglected as the genius of the peoples prompts. The similarities and contrasts of the ancient riverine civilizations of Egypt and Mesopotamia, the relative importance of the east and west entrances to the Mediterranean, the rôle of the rivers of South America and Africa in exploration and economic development, the advantages conferred upon Western Europe by habitability and world position, are but a few of the suggestions set out. Space does not of course permit their development in detail; this is left to the student, aided by the comprehensive bibliographies, largely however limited to German titles. Another commendable feature is the abandonment of a European in favour of a world-wide standpoint.

In a confined space, Prof. Maull, the author of a political geography in which much of Prof. Hennig's material was anticipated, gives a well coordinated description of contemporary political geography. He divides the world into seven spheres of energy, or potential energy, and demonstrates how their interrelations have produced the present political structure. He attaches, as does Prof. Hassinger, rather more importance to the human element and its capacity for utilizing geographical resources. He also writes subjectively, so that his little book, with its statistics and dates, forms a useful introduction to world politics of to-day. G. R. C.

GENERAL

SOUTH COAST CRUISING, from the Thames to Penzance. By CHARLES PEARS. *London: Edward Arnold & Co.* 1931. 9×6 *inches;* xii+240 *pages; illustrations and charts.* 12*s* 6*d*

The author of this book is both artist and yachtsman, and his yacht *Wanderer* flies the flag of the Royal Cruising Club. This small club, whose members cruise widely and some even circumnavigate the globe, has the proud record that but one life has been lost at sea in fifty years of adventure. We may assume therefore that any member who writes on cruising will give sound and practical advice, and that is what this interesting and valuable book offers to its readers. In addition to illustrations from paintings by the author, it contains a series of valuable charts drawn by P. H. Brooks.

Emphasis is laid on the importance of studying tides and of accurately forecasting the possibilities and hazards of a passage; numerous illustrations of the value of the routine consideration of these conditions are to be found as we travel in the *Wanderer* from Burnham to Penzance. There is a description of a thunderstorm at sea off Brighton which is a fine example of the artist's vision expressed in telling and dramatic prose. Those who have had a similar experience will read these lines and revel in their vivid word-painting.

There is a passage about Lymington, "to get to which one sails a winding course across a grass-grown marsh covered at high water. (This grass is of peculiar colour and it is no native to these lands. A steamer, wrecked somewhere near, poured the seed from its holds and it took root hereabout.)" But that is not the true story. The grass in question is the Rice Grass, *Spartina Townsendii*. Previous to 1870 two species were known in the country, *S. stricta* and *S. alterniflora*, and *S. Townsendii* is probably a true-breeding hybrid which has found a congenial haunt on these tidal flats. It is an interesting fact that a similar invasion by a hybrid grass has taken place on the Adour, near Bayonne, under precisely similar conditions of the parent stocks. The phantom ship with its freight of fabulous fertility may safely be regarded as a myth.

Mr. Pears has some hard things to say about Fowey: we doubt if they would have been said if there had been no *Islander* disaster. The *Channel Pilot* states that "coasters embayed between Rame Head and Dodman Point during a southerly gale may run for Fowey harbour with safety"; and the directions for a ship approaching from the eastward are "keep about 1 mile from the shore until Fowey Church tower is in line with Whitehouse Point bearing 26° true, then steer in between the points." If these instructions are followed there is no need to worry about the Washing Rocks, which seem unpleasantly near to the course marked on Chart 9 of Fowey.

Mr. Pears is to be congratulated on producing another work of the same permanent value as 'From the Thames to the Seine,' and we feel sure it will find a place in the library of every one who cruises on the south coast. It will moreover encourage a wider range of cruising in those who hitherto have limited their efforts to the Thames Estuary and the French ports so easily reached from Dover.

H. M. E.

ATLANTIC CIRCLE: around the Ocean with the Winds and Tides. By LEONARD OUTHWAITE. *New York and London: Charles Scribner's Sons* 1931. 9×6 *inches;* xii+310 *pages; illustrations and sketch-map.* 15*s*

The publisher's announcement of this very interesting and exciting tale of adventure is somewhat misleading: "This is the true record of an adventurous voyage in a small schooner across the Atlantic Ocean and back—the story of a

man and woman and small crew contending against the sea and all nature. It is a kind of saga of a modern man, without the aid of the machine, pitting himself against nature." One expects another tale of the type of Mulhauser's 'Amaryllis,' or voyages like those of Conor O'Brien or Stock's 'Dream Ship,' and finds that the *Kinkajou* was 90 feet over all, 71 feet on the water-line, 19·6 beam, and 10 feet draft. "A new Diesel auxiliary was installed, and an auxiliary motor put in, to take care of lighting, refrigeration, water-pressure system, bilge pump, and deck pump." They were fortunate enough to engage Captain Olaf Berg as skipper. The rest of the crew consisted of an engineer, a Nova Scotian sailor, and launch boy, Old Norway, another seaman, a cook-steward, and a steward. It will be seen from the above measurements that *Kinkajou* was a stout ship almost identical in size with the modern drifter-trawlers, which are well known for their seaworthy capabilities. The first part of the voyage from New York to the Azores and then to Southampton, a total distance of 3677 miles, was accomplished in a running time of nineteen days, and the excitement at arriving at Southampton was the occasion of many congratulations; "Captain Berg shook my hand and said, 'Well, sir, may I congratulate you? There aren't many people that have sailed their own ships across.'"

We read next of Cowes, and racing viewed from the "hallowed" vantage spot of the Squadron, and a description of racing on *Westward* with a pen-picture of F. T. B. Davis, whose abuse of four admirals who were yarning and not working on board sounds better at sea than in print: it is the sort of language sailors understand. At Cowes Captain Berg went ashore to meet Diapers and Sycamore, and other racing skippers, and returning to his ship was unfortunately lost overboard.

From this time the responsibility of captaining the ship devolved on the owner. Going down Channel *Kinkajou* ran into a thick fog and nearly on to the Casquets, in spite of every precaution. In the Bay of Biscay she had to stand up against five days of an October gale, and came through bravely; but the discomfort and unutterable fatigue that almost overwhelmed the crew is described in realistic prose.

The chapter on the Desert Coast tells how, in the absence of a detail chart of the Senegal coast, they made the port of Dakar. The owner improvised a chart by plotting out all positions and observations given in the *Admiralty Pilot*. "We had a line-of-position plotter on board with graded scales for the various latitudes, and using this and the British Admiralty pilot book for positions and directions, we soon ran off a rough chart to scale of the approaches to Dakar." The plan worked well and the author states "the fact that it is possible to construct such rough charts is itself evidence of the high state of detail and accuracy to be found in the British Admiralty texts." A description of Peanut Kingdom is followed by one of the Middle Passage, and we must leave our author at Trinidad, after thoroughly enjoying an original and intensely interesting record of travel.

H. M. E.

THE WHITE HORSE OF UFFINGTON

Of some fifteen figures of white horses cut in the turf of the wide chalk downs of Wiltshire and Berkshire three can be seen by travellers on the Great Western Railway—two on the line through the Vale of Pewsey, and the other on the main line through the Vale of the White Horse. This, the celebrated White Horse of Uffington, is the only one of the Wessex figures of any antiquity. In the March number of *Antiquity* Mr. Stuart Piggott, after pointing out that the figure has been cited as a landmark since the eleventh century, and referring to Thomas Hughes's 'Scouring of the White Horse,' and the Rev. W. C. Plenderleath's 'White Horses of the West of England,' goes on to consider Sir Flinders Petrie's 'Hill Figures of England,' in which is published for the first time an accurate plan of the Horse. Taking exception however to certain points in Petrie's description, Mr. Piggott passes on to examine critically the style of workmanship of the Horse, its associations and its parallels with a view to determine the date, the culture to which it belonged, and the reason for its making.

The grotesque figure has been taken by some for a dragon, the adjacent Dragon's Hill being held to give countenance to this supposition. But among other archaeological evidence for the figure being a horse Mr. Piggott finds that a *horse* with just such attenuated body, disjointed limbs, and peculiar head is specifically represented on a large and well-known series of gold and silver coins minted in England towards the end of the Early Iron Age, probably in the first century B.C. The Horse appears to have had religious significance, and has been suggested by Mr. Crawford (*Antiquity*, 1929, iii, p. 281) to have been the tribal emblem of the neighbouring hill forts of Uffington Castle and Alfred's Castle which date, according to Mr. C. F. C. Hawkes, from a similar period. The theory of the association of the Horse with King Alfred's victory in A.D. 871 appears to date only from the eighteenth century, but local tradition asserts that Dragon's Hill is so called because St. George killed the Dragon there, and that no grass will grow where the blood was spilt. The scouring of the White Horse, until recently done at irregular intervals by the local people, was always a festive occasion, and no doubt the survival of an ancient ritual. The last occasion was in 1857, as described by Hughes. Nowadays local interest has declined, and it is left for the Office of Works under the Ancient Monuments Act to keep the chalk clear of weeds by more prosaic methods.

Mr. Piggott concludes that the early date B.C. is all we know for certain about this celebrated figure.

THE SWISS GLACIERS IN 1930

The fifty-first annual report on the variations of the Swiss glaciers, by Professor P. L. Mercanton, is printed in the monthly publication of the Swiss Alpine Club for June. The report begins with a short general sketch of the course of precipitation and state of the snows through the year, which shows that while the season was deficient in winter fall it was also unfavourable to summer melting, so that the net result was an excess of accumulation. Coming to the glacier observations the results are as usual tabulated under the headings of the chief river basins, that of the Rhone naturally taking the first place. In all 96 glaciers have been under observation, 41 belonging to the Rhone basin. In each of the eight groups the number found to be decreasing far exceeded the sum of those stationary or increasing, the percentages of each class being respectively 80, 12, and 8. This is ascribed principally to the deficient winter fall, but partly also to the

effect of copious summer rains. The comparative figures for 1928 and 1929 show that the same diminution has been in progress, on the whole, during all three years, but that it has been slightly greater in 1930 than in 1929. The notes on individual glaciers bring out some interesting points. The retreat of the Rhone glacier has led to the disappearance of the fine terminal façade which for some years had been the admiration of tourists. A more remarkable fact however is the entire separation of the upper from the lower portion of the Arolla glacier, an event first ascertained in August 1930 by M. Renaud, though foreseen for some time. The upper glacier is one of three main branches, that of Mont Collon being the next in importance. At present the former does not even reach to the old point of junction, so that the glacier as a whole ought now to be properly known as that of Mont Collon.

ECONOMICS OF THE RHINE AND MEUSE

Two useful studies of present economic developments on the Rhine and Meuse have lately appeared in Belgium. The larger river is dealt with by Professor A. Delmer, of Liége, in a lecture printed in the *Bulletin du Cercle des Géographes Liègois*, 2me Année, 2e fascicule. He considers the Rhine both as a source of power and as a means of transport, the two uses being closely linked together. The power available is of two kinds—that derived from the streams in the upper Swiss valleys which can be regulated by reservoirs so as to give a fairly constant supply, and that obtained at river-level on the Middle Rhine itself, which necessarily varies with the stage of the river; and it has been found practicable to combine the two sources so that one supplements the other. The energy supplied by the Swiss head-streams will soon reach a million horse-power, representing an annual saving of 5,000,000 tons of coal. That derived from the Rhine and Aar at the foot of the mountains has not yet exceeded 500,000 horse-power, but is capable of great development. On the Middle Rhine below Basel questions of power and navigation go hand in hand. Works carried out in 1907–14 have shifted the head of major navigation up-river as far as Kehl-Strasbourg, and the chief problems concern the higher section between the latter and Basel, where navigation needs improvement either by regularizing the existing channel or by a lateral canal. The Alsace canal scheme, provided for by the treaty of Versailles, contemplated taking from the river at Basel 800 cubic metres of water per second and conveying it to Strasbourg in eight stages, with locks and a power station at the end of each. The first section, of 6 km., will be completed next year, but the author expresses a doubt whether the scheme will be continued as originally planned. Regularization and canalization are mutually exclusive, as the water supply cannot suffice for both. The Alsace canal is not favoured by Switzerland, who has dreamed of the extension of free Rhine navigation to her frontier, and works for regularization have already been undertaken by the German and Swiss Governments. It is also a question whether the energy produced along the canal could compete with that supplied by the Alpine reservoirs, for schemes to supplement it by reservoirs in the Vosges involve great expense. Altogether, the amount of energy to be derived from the Rhine and its affluents will be equivalent to an annual consumption of 12 to 15 million tons of coal. It will be carried long distances from the points of origin, so that the river's importance as a link between different regions, already great from its function as a means of transport, will in this way be still further enhanced.

The second paper, by L. Ardent, is entitled "Le Problème de la Meuse" (Brussels, 1931). This problem consists in improving the navigation below Liége, and the conflicting interests of Rotterdam and Antwerp here come into play. A solution which might have served the needs of both was the scheme for

improvement (1) of the canal from Liége to Maestricht; (2) of the century-old Zuid Willemsvaart, which cuts off the easterly sweep of the Meuse and debouches on the lower river at Crève-coeur: it has done good service to both countries, but cannot take barges of over 450 tons; (3) of the Meuse–Scheldt junction canal, putting Antwerp into easy communication with the east. But negotiations to this end came to nothing and the two countries are now working independently—Holland by canalizing the lower Meuse throughout; Belgium by constructing a new waterway—the Albert Canal—from Liége to Antwerp by Hasselt. The canalized Meuse will serve the Dutch coalfields (1) of Limburg, (2) another farther north not yet exploited; the Albert Canal will serve the Liége field and that of the Campine which it skirts to the south.

Both papers are illustrated by adequate maps.

ITALIAN SURVEY IN TRIPOLI

The Italian Hydrographical and Military Geographical Institutes last year carried out in conjunction a survey of the coasts of the Syrtis of Tripoli, and a brief sketch of the operations is given in the April 1931 number of *L'Universo* by Guido Masserano. The work involved some difficulties by reason of the entire lack of resources in the almost waterless tract to be dealt with and the somewhat unsafe conditions, but they were overcome by careful organization. A secant conical projection was chosen for the map, with standard parallels 30° and 32° 50′ N. lat., and central meridian 17° 50′ E. long. The new International Ellipsoid of reference was adopted in place of that of Bessel previously used for geodetic work in Tripoli. An astronomical station for latitude, longitude, and azimuth was established at Misurata Marina as starting-point for the new work, and a base measured there. By arranging that one side of the triangulation net should coincide with one fixed in 1914, the new work was linked to the old. In a region devoid of striking features it was found advantageous to make a preliminary plane-table reconnaissance while the signals were being set up. The network for which the Military Geographic Institute was responsible extended 360 km. along the coast to Marsa el Auegia, where it joined that of the naval detachment on the coast of Cirenaica. The sides of the triangles varied between 10 and 15 km., and the three bases measured by the military party with invar tape had lengths of about 1000 m. each. Special care was needed in taking the zenithal observations on account of the effect of mirage on the coefficient of refraction, the mean value of which worked out as 0·12. The typography of the Coastal zone was plotted on the scale 1:100,000.

AN EARLY ITALIAN TRAVELLER ON THE UPPER NILE

A propos of the paper by Commander Whitehouse on the mountain tract east of the Upper White Nile (*Journal*, February 1931), Professor Almagià gives in the *Bollettino* of the Italian Geographical Society for May some interesting notes on a little-known Italian missionary, Angelo Vinco, of Verona, who visited the same region some years before Sir Samuel Baker's time. He was one of the party sent to Khartoum under Knoblecher in 1848 on the establishment of the Vicariate Apostolic for Central Africa. In 1851 he founded a station among the Bari tribe, south-east of Gondokoro, with which relations had lately been formed by the French trader Brun Rollet. Pushing east thence, he crossed a river named Ciol (Shol) which he took to be the headstream of the Sobat, and which may perhaps be identified with the Kineti of the modern map, the crossing-place being apparently a little below Torit. The river separated the Bari from the Beir or Beri, beyond which tribe lay the habitat of the Lopeit, and Latuke. From a hill in the country of the Latuke he descried a chain of mountains terminating in

Mount Imadon (the Imatong of recent travellers), and his narrative mentions various peaks, some of which appear on Commander Whitehouse's map. He received information of routes to the south towards the Nile sources and attempted to push in that direction, without however getting beyond 4° N. Short notices of these journeys appeared at the time in the *Bulletin* of the Paris Geographical Society, but the most detailed account, given in an Italian missionary journal in 1853, has remained practically unknown. One result of Vinco's reports, particularly his mention of the supposed upper course of the Sobat, was the attempt made by two Italian ivory traders to ascend that river to the Beir country, and though they failed in this they broke some new ground in the Sobat basin. A station is even now maintained by a Veronese Mission in the tract first explored by Vinco.

FRENCH PROGRESS IN SOUTHERN MOROCCO

From its relative inaccessibility, Morocco south of the Atlas has had to wait longer than the rest of the country to be brought under French control, but striking progress has been made within the past few years, as is well brought out in an article by Victor Jean in *L'Afrique Française* for May of this year. It is pointed out that Morocco has from early times played the important rôle of a link between Mediterranean Europe and Tropical Africa, and that it was imperative to open up routes across the Atlas and Anti-Atlas towards the plains and oases beyond, small as may be their intrinsic value. Marakesh has been the starting-point for this advance, and though held up for a time by the war and by troubles in Northern Morocco, as well as by difficulties of communication, it has gained ground year by year since 1925, so that whereas the advanced positions were then only some 30 km. south of the capital they have now been pushed forward some 400 km. The process has been helped by the relations already existing with the inhabitants of the southern plains, who have been compelled by the poverty of their country to seek periodic employment in Morocco proper; and it has been found possible of late to gain their goodwill and avoid any display of force. Road-making has kept pace with the establishment of political relations, and the amount accomplished is clearly shown in a map accompanying the article. The first objective was Taurirt, in the Warzazat district, to reach which the Main Atlas had to be crossed. The road traverses the Tishka pass at an altitude of 2250 metres, leading through scenery well calculated to attract tourists. Taurirt was reached in 1928, and in the next two years the road was carried thence north-east by the fertile oasis of Skura, following the valley of the Dades, an upper branch of the Draa, and crossing the watershed towards the basin of the Ziz. This road, which follows a route reconnoitred nearly half a century ago by De Foucauld, serves all the Glaui country south of the Atlas. Since 1929 Taurirt has been put into direct communication with the west coast at Agadir by way of Tarudant, being thus accessible by an alternative route when the high passes are blocked by snow. From Marakesh a second main route crosses the Atlas by the Tizi n'Test pass at a height of 2200 metres, and leads south-west to Tarudant and the Sus, only the highest section being yet incomplete; and various subsidiary roads are either open or under construction. The article is illustrated from photographs including some striking views of the imposing citadels at Taurirt and Skura.

THE MUSK OX IN CANADA

An area of 15,000 square miles along the Thelon and Hamburg rivers east of Great Slave Lake was set aside in 1927 as Thelon Game Sanctuary for the protection of the known remaining herds of musk oxen on the Canadian mainland.

In January 1928 Mr. W. H. B. Hoare was sent to make a census of wild life within the Sanctuary and investigate the conditions of musk oxen and caribou. His results, published by the Department of the Interior in 'Conserving Canada's Musk Oxen,' give an interesting account of the habits and seasonal migrations of the musk oxen. From Appendices by Mr. Hoare and Dr. R. M. Anderson, on musk oxen and caribou, it would appear that the number of musk oxen now alive on Canadian territory is about 13,000, which with a further 1500 in Greenland gives a total of 14,000 or 15,000 in the world to-day, for these are the only two countries where this species is found wild. A map indicates the present range of the musk ox in comparison with that in 1870, which was greater, and another shows the areas of maximum density of Barren Ground caribou distribution.

THE COASTS OF PORT PHILLIP BAY, VICTORIA

The origin of an almost land-locked area of water like Port Phillip Bay raises interesting questions, as yet only partially solved. Its formation is usually regarded as due to a comparatively recent submergence by the sea of a low-lying area, followed by a partial closing of the mouth of the bay so formed by the growth of sand-dunes, now hardened into a sandy limestone. The most recent history also suggests problems, particularly whether traces of recent uplift can be discovered. An investigation of the shores has lately been carried out by Mr. J. T. Jutson, with a view to studying the conditions of erosion and sedimentation now prevailing, and the preliminary results are described in the *Proceedings* of the Royal Society of Victoria, vol. 43, part 2, 1931. It is found that on the whole the eastern side of the bay is an area of erosion, the western of sedimentation. The primary causes of the former are thought to be the strong current sweeping along that side, and the waves raised by the strong southerly and south-westerly winds. In places these agents find nothing but little-consolidated sands, such as form the cliffs at Mentone, where erosion is severe enough to cause much anxiety. As there are no streams of any size entering the bay on this side, there is no river-borne detritus to be first removed. There are one or two exceptions to the general rule, *e.g.* in the Rosebud area there are extensive marine deposits. At the head of the bay the coast is moving forward owing to the large amount of detritus brought down by Yarra and Maribyrnong rivers. On the western side the rocks are mainly the hard Newer Basalt which resists erosion, while on the other hand there are rivers to bring down sediment, and some is probably brought from the eastern side by a current. Swan Bay, on the eastern side of Bellarine peninsula, is a huge area of sedimentation. An interesting feature of the western shore generally is the number of old minor bays which have been cut off from the main bay by the formation of bars. No very definite evidence was found to decide the question of a small recent uplift, but the general tendency is against such an idea, for Mr. Jutson considers that all the features of beach ridges, depressions, and low-lying flats which have been put forward in its favour may be interpreted as formed with sea-level as at present. Other facts may perhaps be read as indicating uplift, but further investigations are needed, particularly a series of levels at critical localities, before a definite pronouncement can be made.

EQUAL-AREA PROJECTIONS OF THE SPHERE

In the *Journal* for November 1929 Lieut.-Col. J. E. E. Craster published a note on a series of equal-area projections of the sphere, in which the meridians were conics, and compared them with the projections of Sanson, Mollweide, and Boggs (the "Eumorphic" described in the *Journal* for March 1929). Colonel Craster has recently informed us that the expressions he gave for the parabolic

equal-area projections contained an obvious error: the equation of the parabola should be $y^2=\frac{1}{2}x$; and the distance from the equator of the parallel of latitude is given by $3y-y^3=2\sin\phi$. He adds that one of his pupils, Mr. P. C. Bartrum, has pointed out that $y=2\sin\frac{1}{3}\phi$ is a solution of this equation, and gives a simple means of calculating the parallels.

Meanwhile Mr. Oscar Adams, of the U.S. Coast and Geodetic Survey, has published in *The Military Engineer* for May–June 1931 an account of this parabolic equal-area projection with more accurately computed tables, and an "interrupted" map of the world on this projection drawn by Mr. C. H. Deetz, which is believed to be the first example of its use. The central section is 160° broad on central meridian 100° W. of Greenwich; the side sections are each 120° broad, with an overlap of 40° in the extreme longitudes. The author considers the result superior to the Sanson projection; and it has the advantage over the Mollweide that the parallels are much more equally spaced. The specimen produced is rough in outline and the graticule is not figured; it makes a fair representation of the Americas, but naturally at the expense of Asia. For text-book diagrams it may be well adapted: and we shall doubtless see other experiments in "interruption." But the only merit of the straight parallels is that they are easy to plot. If interrupted world projections are to become fashionable, there will be something to say for using the zenithal equal-area projection as the basis.

PIONEER DESERT EXPLORATION: AUTHOR'S NOTE

Mr. W. J. Harding King wishes to make a small correction in his paper on "Pioneer Desert Exploration" published in the June number of the *Journal*. In the words "adjusted in the manner described" in the second line of the third paragraph on page 545, and again "not so adjusted" two lines lower down, he was inadvertently referring to a part of the paper which he had cut out in revision. In this section he assumed that A and E, in the imaginary route given on page 541, were accurately fixed points, and emphasized the importance of collecting information, when possible, in the form of through routes joining known places of this kind, in order that after checking and plotting, the guide's data might be adjusted and errors distributed by the ordinary graphic methods. In the present form of the paper the paragraph in question claims too much for this method of mapping.

Annual General Meeting, 22 June 1931. The President, Admiral Sir William Goodenough, in the Chair.

The Hon. Secretary (Brigadier-General E. M. Jack) read the Minutes of the meeting held on 23 June 1930, which were confirmed and signed by the President.

The PRESIDENT then proceeded to the presentation of the Medals and Awards and said: Mr. Bertram Thomas, His Majesty has approved the award to you of the Founder's Medal; not only for your most successful and indeed unique journey across the Rub' al Khali, but also for the long study and research of all the circumstances and conditions of Southern Arabia which have resulted in such brilliant additions to our knowledge of that country. Your name makes a fit addition to the long list of those to whom this Medal has been awarded.

Mr. BERTRAM THOMAS: I thank you, Mr. President, for this treasured reward for my slight journeys in Arabia and you, ladies and gentlemen, for the warm manner in which you have approved of it. I would like to express my indebtedness to the Royal Geographical Society for much inspiration and assistance, and to you, sir, for many kindnesses since my return. I would also like to express my indebtedness for the instruction I received from Mr. Reeves in 1925, and to Mr. Hinks, who has always helped me with patience in my many difficulties. I thank you again, sir, and you, ladies and gentlemen, for this very high honour.

The PRESIDENT: Captain Galbraith, in the regretted absence of Admiral Byrd himself, I have great pleasure in inviting you to receive for, and to transmit to, Rear-Admiral Richard Byrd, your brother officer and mine, the Patron's Gold Medal of which His Majesty has approved the award.

Of the many attributes which are required for leadership of Polar research, personal daring and personal skill are among the foremost. It required long preparation of flying in arctic conditions to enable Admiral Byrd to fly from Spitsbergen to the North Pole and back. Admiral Byrd was, I believe, the first to use the graphical methods of navigation on Polar flights. We still have to look forward to all the results which will accrue to us and others from his expedition in the Antarctic. It was a remarkable feat to fly over the South Pole at such a great height, and members of his expedition will have some valuable geological and geomorphological results to give to the world. It is an immense pleasure that we should be able to honour him in this manner.

Captain GALBRAITH: Rear-Admiral Byrd regrets that he cannot be present personally in order to accept the Medal which has been awarded to him for his services. Such a recognition on the part of the Royal Geographical Society is an honour which is cherished by every recipient, and I can assure you that it is much appreciated by Admiral Byrd. It gives me very great pleasure to attend and accept the Medal on his behalf, and I shall transmit it to him through my department.

The PRESIDENT: Colonel Rowe is still on the West Coast of Africa. We may claim him as a pupil of this Society. He has been employed in the Trigonometrical and Topographical Branches of the Nigerian Survey Department and produced the first accurate maps of that country. After the War he was appointed Surveyor-General of the Gold Coast; and he is now Commissioner of Lands in Nigeria. Colonel Rowe has been awarded the Back Grant for his Surveys of West Africa, and has chosen to take the grant in the form of a silver bowl. It is very fitting and a great pleasure to all of us to see one bearing a name so honoured in our Society present to receive the award on behalf of her cousin, Colonel Rowe. I ask you, Miss Murchison, to receive this silver bowl.

Miss MURCHISON: It is with very great diffidence, I assure you, that I raise my frail feminine pipe before a Society whose former members listened to the presidential addresses of my distinguished ancestor, but I am here now, on behalf of my cousin, Colonel Rowe, to accept the Back Grant awarded to him this year, and to assure you, in his name, how deeply he appreciates the honour that has been done him. I am to tell you from him that he will always treasure this bowl as a record of very hard but happy times spent in survey work on the West Coast of Africa.

The PRESIDENT: The Murchison Grant has been awarded to Mr. Nesbitt. Mr. Nesbitt's journey in Danakil has been fully described in a series of articles in the *Geographical Journal* last year. It was a remarkable feat of courage and endurance, for it is well known that the country is a difficult one to traverse and its inhabitants are not as a rule peculiarly sympathetic towards strangers. It is a country hitherto little known, and Mr. Nesbitt has traversed the whole length of it from north to south. I ask the Hon. Secretary to accept the grant and to transmit it to Mr. Nesbitt.

The PRESIDENT: Mr. Beadnell, in the many years that you have been in the service of the Egyptian Government you have become recognized as one of the finest exponents known of desert travel, and we are indebted to you for several important papers contributed to the Society, including one on Central Sinai in 1926. The Cuthbert Peek Grant which is made to you entails no obligation, but it takes with it the expression of a hope that those who receive it are considering the possibility of further exploration, and we can well imagine that that, sir, is always in your mind.

Mr. H. J. L. BEADNELL: This recognition by the Royal Geographical Society of my work on the Survey of Egypt is very much appreciated by me. I am glad to hear from the President that the Cuthbert Peek Grant entails no obligation, but I do realize that it carries with it the expectation of further work, and this I hope to be able to arrange. I assure the Council that this Grant will be of material assistance to me financially, for it is difficult to raise funds for private work nowadays. The Egyptian desert has attracted a good deal of attention during the past few years, and the various expeditions, more especially those of His Highness Prince Kemal el Din, have left no great areas entirely unknown. There are however many problems which require further investigation, and it is with the object of studying some of these that I hope to return to Egypt in the near future. Thank you all very much indeed.

The PRESIDENT: Mr. Michael Spender, you have been awarded the Gill Memorial Grant for your work on the Great Barrier Reef, and we are indebted to you for your papers published in the *Journal* and in particular to your beautiful map of two Coral Islands. We are glad to hear that you have been studying the methods of stereographic survey, and we look forward to your work in this direction having considerable effect in stimulating the practice of photographic survey in Great Britain.

Mr. MICHAEL SPENDER: I am deeply grateful for this honour. I must also express my thanks for the opportunity that was given to me to carry out the work in Australia: particularly for such an opportunity given to some one who at that time was not personally known to the Society. I cannot exaggerate what it means to any one, whether their work be far away in Australia or no farther than the continent of Europe, to have behind them the backing and kind thoughts of the Council of the Royal Geographical Society.

The PRESIDENT then delivered his Anniversary Address, which is printed on p. 97.

The visitors having withdrawn, the PRESIDENT appointed Sir Henry Galway

and Captain John Morris to act as Scrutineers of the Ballot for the President and Council for the ensuing year.

In moving the adoption of the Annual Report of the Council, the PRESIDENT said: May I call particular attention to the finances of the Society. You will note a deficit on the year's working of £591. It was preferable, and incidentally more honest, to show that as a deficit than to hold up the annual repayment of £500 of the loan. The deficit was caused by the expenditure on the Centenary of nearly £1100, and therefore is not recurrent. It is early to make a positive statement, but in all probability the annual expenditure on account of the new buildings will entail an increase of about £600, and as against that there is set off a sum of about £270, the amount we used to pay for the hire of the Aeolian Hall. There will in the course of a few years be, naturally, an addition for maintenance and repairs, in spite of the fact that we believe the place is well built. That is one of the reasons why we want an increase of Fellows; we want to make quite sure we are on firm ground. The increase of one hundred Fellows over the present number would represent an increase in funds to the extent of £300 a year. The Building Fund Account is not yet complete, but it is sufficiently advanced for me to be able to put before you the main figures, which show that the estimates and actual expenditure work out fairly consistently. Next December the company which has built the flats and now pays ground rent to the Society will have to exercise their option, *i.e.* either to continue to pay £2000 a year or to purchase the freehold for £40,000. The Fellows may rest assured that their interests will be safeguarded to the full. In conclusion I would point out that the subscription list is still open and that the Society is ready at all times to receive such additions to the Building Fund from which it might be possible to put something towards the Maintenance Fund, a course which many think desirable. If there are any questions Fellows wish to ask, now is the time.

Brigadier-General E. M. PAUL seconded, and there being no questions, the PRESIDENT put the motion to the vote and declared the Report adopted.

Sir HENRY GALWAY reported that as a result of the Ballot all the Candidates proposed by the Council had been unanimously elected by the Meeting (see List, p. iii).

The proceedings then terminated.

THE ANNIVERSARY DINNER

The Anniversary Dinner of the Society was held at the Connaught Rooms on Monday 22 June 1931.

The President and the Hon. Lady Goodenough received the company, which included, among the Guests of the Society: the Italian Ambassador and Donna Diana Chiaramonte Bordonaro, the Prince and Princess Reginald de Croy, the Rt. Hon. Leopold Amery, M.P., and Mrs. Amery, General Sir Archibald and Lady Montgomery-Massingberd, Vice-Admiral Roger and Mrs. Backhouse, Captain W. W. Galbraith, U.S.N., and Mrs. Galbraith, the President of the Royal Society and Lady Hopkins, the Director of the Royal Institution and Miss Bragg, the Director of the British Museum, and Professor and Mrs. Holtedahl.

After the loyal toasts had been honoured Mr. LEOPOLD AMERY, in proposing the toast of the Society, said: I cannot but recall to mind the fact that the last time the toast of the Society was proposed at your Annual Dinner it was by a very gallant and debonair gentleman and lover of high adventure, the late Lord Thomson. In his speech on that occasion he laid especial stress on his belief in the future importance of the airship, more particularly in connection with geo-

graphical reconnaisance and survey. A few weeks later he passed, if I may use the splendid motto of the Air Force, *per ardua ad astra*, to fame by the steep ascent of death, together with almost the whole of this country's equipment of experts in airship navigation, in the disaster which befell the R 101. I rejoice, as I know he and all his comrades would have rejoiced, at the thought that the British Government has not been deterred by that mischance from prosecuting the work of practical research into a form of transport which I believe may yet prove to have immense possibilities, once experiment has justified construction of airships sufficiently large to be both strong enough and buoyant enough to achieve their purpose.

Since I myself last had the privilege of proposing this toast three years ago many things have happened. Not least has been the Centenary of the Royal Geographical Society itself, an event which was celebrated with the dignity which the occasion warranted, both by the Society and by its kindred societies all over the world which sent their delegates to join in wishing the Society what I also wish it to-night, many happy centenaries to follow. And may the new Lecture Hall, the realization of Lord Curzon's dream as well as of the tireless activity with which he translated his dreams into action, long continue to serve all the needs of the Society until such time as its ever-expanding activities may justify the incorporation of the Albert Hall in its enlarged premises.

Meanwhile the work of opening up the unknown places of the Earth has steadily progressed. During the last twelve months more than one remarkable feat of exploration and discovery has been accomplished. I need say nothing about Mr. Bertram Thomas's splendid expedition through the heart of the Arabian desert, for that will be the theme of the next toast; but I should like, at any rate, to make a passing reference to the importance of the work carried out in Greenland by the Cambridge Expedition under the leadership of Mr. Watkins, as well as by other expeditions which are gradually filling in the details of the map of that great island. The heroic endurance of young Courtauld, the tragic death of Dr. Wegener—a notable name in the history of geological theory—should not obscure from us the fact that these pioneers have been engaged in prospecting work upon what may soon become one of the ordinary unromantic high roads of the world's passenger traffic, and that on the site of Courtauld's winter vigil may before long arise the refreshment buffet where sandwiches and coffee will be partaken of by travellers on their way from London to Vancouver.

If the Arctic regions are destined to become the Piccadilly Circus of the traffic of a world which lives mainly in the Western Hemisphere, the Antarctic will, I fancy, always remain comparatively quiet and aloof—once, at any rate, the main features have been properly filled in on the map. In that respect much good work has been done during the past twelve months by Commander Byrd, who has reconnoitred a large area of the continent from the air and paid his respects to the historic memory of others who have visited the South Pole; by Sir Douglas Mawson in the old *Discovery* along what I may call the Australian sector of that Antarctic continent; by the *Discovery II* from the Falkland Isles; and by Dr. Holtedahl, whom we are glad to see here to-night, in the *Norvegia;* all these between them have done good service in opening up the Antarctic seas as well as in the study of their hydrography and marine ecology. I might add that I heard a few days ago from Sir Douglas Mawson that his expedition had named an angle of the Antarctic Continent between McRobertson Land and Princess Elizabeth Land, wherever that may be, after me. Last time such an honour was accorded me it was in the shape of a mountain in the Canadian Rockies, and I hastened at the earliest opportunity to justify the appellation by being the first person to ascend the mountain. I should like to sail to Cape Amery if I felt the political

situation at home was stable, but I should hate to be left addressing the penguins when the General Election was taking place over here.

To turn from the political to more serious impending geographical events, there is a grave question that I gather confronts your Society with increasing urgency every year: what is to be done when there are no new regions to discover, no places worth writing papers about, no places to which Mr. Thomas and others can go in the hope of receiving a gold medal? I gathered from you, Mr. President, that you wish me to direct my thoughts to that very critical theme. There are, it is true, new worlds the possibility of whose conquest, fantastic as it may seem at present, may one day be opened up by the advance of science. The remarkable progress made in recent years in diving apparatus may suggest that the time is not very far distant when submarine vehicles, like glorified tanks, will trundle along the ocean beds, startling submarine monsters with their headlights, and open up for us a new geography and cartography of the deep-sea world. Nor can we regard Dr. Piccard's pleasant afternoon in the stratosphere otherwise than as a precursor of some future expedition, no doubt jointly financed by the Royal Geographical Society and the Alpine Club, to the mountains of the moon.

Pending those developments I would suggest that there is still an immense amount of filling in and rounding out to be done by the Royal Geographical Society before the knowledge of the Earth's visible surface is complete. The geological basis of that surface, in its bearing on the changing configuration of its main land masses, is still far from finally ascertained. The reciprocal influences of geography and meteorology upon each other offer another field of research as interesting from the speculative point of view as important in its practical bearing upon human life. Is the Sahara a complaint that can be cured? What practical steps can be taken to deal with the next Ice Age? Crude questions, no doubt, but questions which have their relevance to the history of the past as well as to the possibilities of the future. I sometimes think that our broad retrospect of history is apt to be not a little distorted by our overlooking the fact that very considerable climatic changes occur every few hundred years, changes we are apt to forget when thinking of the kind of population that may have lived in a certain country at a certain age. It may be as well if, in planning for the future, we pay some attention to such developments in that field as may be ascertainable.

Most interesting, perhaps, of all the detailed fields of geographical study is that immense field in which climatic and geographical conditions and the inherent activities of living matter—vegetable, animal, or human—combine to create that history and map of the disposition of plants, animals, and human beings which is technically called ecology, a science of which, in one respect at least, human history is only a branch. All these branches of research demand an infinitely fuller survey than we yet possess. The actual physical survey of the Earth's surface, or indeed of the Empire, is still far from complete, and even you, Mr. President, would admit that, given funds, the Hydrographic Department of the Admiralty could still find plenty of important work to do. So, while we may dream of the days when our descendants will launch out upon their voyages of exploration across inter-stellar space, we can rest well content with the more immediately feasible and no less important task of consolidating the gains of past exploration, and clothing the now ascertained framework of elementary geographical fact about our planet with the living tissue of that fuller and richer knowledge which springs from the marriage of geography with all her kindred sciences.

I have great pleasure in giving you the toast of the Royal Geographical Society and in coupling with it the name of my old friend and colleague in the Naval

Service, your President, Admiral Goodenough, whose high abilities, wide knowledge of the world, in the geographical as well as every other sense, and infectious enthusiasm have been so whole-heartedly placed at the disposal of your Society.

The PRESIDENT, in responding, said: During the last one hundred years this toast has been proposed by many men of great distinction. I think you will agree with me that it has never been proposed in terms which showed a greater comprehension of the aims and objects of this Society. Mr. Amery speaks with authority in these matters, both because of his distinction as a traveller and his great experience as an administrator. Moreover, Mr. Amery is an old friend of this Society, and we can assure him that we will pay the greatest attention to any remarks he cares to make and always welcome them. He has put some tasks before us. The difficulty I have is not to find a subject but to choose one.

I made some attempt this afternoon to pass in review the activities of our Society during the last twelve months. Have no fear; I am not going to repeat them here. All I would say is that those who were at the Annual Meeting, at any rate, had an opportunity of hearing what I said; those who were not there and care to read of those activities in the *Journal* can do so; and those—well, this is a free country, more or less. Besides which the circumstances are different. This afternoon I spoke as your President. This evening I am your mouthpiece to reply to this toast, and, as I say, it is not so easy to choose a subject.

One might take a book off the shelf—Owen Lattimore's 'Desert Route to Turkestan,' or that classic on Arabia by Philby. But I believe that the most encouraging reply that is to be given to Mr. Amery is to speak of the recognition which has been given to the science which we profess by the Universities throughout the country. Whereas one hundred years ago there was not a single Professor of Geography in the country there are now no less than ten. Cambridge only last year raised the status of its Readership in Geography to that of Professorship, and we are glad to have the Professor of Geography at Cambridge on the Society's Council. And only on Saturday last you will have seen in the newspapers that Congregation—those graduates of Oxford University will forgive me if I do not use the exactly correct expressions, for I was brought up in a somewhat ruder school—adopted a similar policy. Not only that, but they have invited this Society—again I may not be quite correct—to send a representative to sit on the Board which will have to elect the Professor. That is very encouraging, and we may claim to have had some influence in making that advance. In that connection there is one whom I would mention particularly, that past-President of the Society whose mind will never grow old; and may I say that if ever man justified his name it is he who will ever find new areas, I might say "fresh fields," to work on. It is largely due to Douglas Freshfield, and to the late Sir John Keltie, that these advances have been made.

This is an age of treaties and pacts and conventions, and there is no doubt that the increase of knowledge and apprehension that will be given to the coming generation at all the Universities will enable them to come to a judgment of international and other affairs with a broad outlook and to take many things into consideration denied to people of a past generation.

Mr. Amery has asked us some pertinent questions. Besides that which I have already mentioned there comes that ever-increasing and unceasing problem of what is going to happen to what is now called the surplus populations, surplus to their countries of origin, not only ourselves but many others. It appears to me to be geographical work of the greatest importance that we should obtain a knowledge of countries now unproductive that will form the homes in the future of those of whom I have spoken. I do not for a moment believe that we are so derelict of resources as not to be able to find a place in this world for an ever-

increasing population. I do not share, and I think, speaking in your name, I can say you do not share, the gloomy foreboding of those who say that a numerical decrease in the population is the hope of happiness for mankind in the future, as if we were, what shall I say, like the brontosaurus or the bison, to serve some little purpose of Nature for a few years and then be relegated to the obscurity of a museum or the segregation of a national park.

But some may remember that last October I spoke of exploration being the advance guard, and that after that came the various investigations which, as my predecessor so rightly put it, were to be carried out in the cause of humanity. I am very glad to be able to dispel any doubt that we in this Society spend too much time on exploration and not sufficient on its development. I can assure you that we do realize to the full the duties and the privileges of geographical science in its broadest aspect, and that one of the problems which we are ever ready to discuss and to hear other people discuss is where to find places on the Earth where people can live in happiness and security. I remember very well talking, as I had the privilege of often doing some few years ago, to one of our most distinguished Honorary Members, Jan Smuts, and he told me that the thing that had kept him happy in a varied and, it is true, somewhat troubled career was his incurable optimism. I rejoice to see that we have another optimist in Mr. Amery when he proposed this toast, and we should all be proud to share that optimism with him. We can look to the future of new places discovered where fresh communities, with perhaps entirely different ideas from those which we have, will live. We have too much faith in the future of our country and our nations, whether it be that of your Excellencies or your Highnesses or that of my brother officer, Captain Galbraith, to imagine that we are going to sink into obscurity for want of room on the Earth. Mr. Amery spoke of that, and I can assure you that we will follow up all he said in that direction with the greatest possible vigour. The world is full of interesting problems: never more so than now. We believe that in this Society we may be able to assist in the solution of some of those problems. Therefore I would say to the Fellows of the Society, bring your friends to help us towards those solutions. We believe that they will find their time and, incidentally, their money well invested.

I thank you, Mr. Amery, on behalf of the Royal Geographical Society, most heartily for having found time in so busy a life to come here. You may rest well assured that the oftener you come to our Society in any capacity, whether that of speaker or listener, and bring Mrs. Amery with you, the better we shall be pleased.

Sir MATTHEW NATHAN, in proposing the toast of the Medallists, said: I am going to speak to you about Antarctica, Asia, Africa, and Australia. But you need not be alarmed; I am not going to treat those continents exhaustively but only to tell you something of the gallant fellows, mostly Fellows of this Society, who have wooed them and forced their secrets from them.

First of all, with regard to Rear-Admiral Byrd. As you all know, Commander Byrd flew to the North Pole in 1926, across the Atlantic in 1927, and to the South Pole in 1929. Verily we can say of him that he joined continents together and that he went to the opposite ends of the Earth. But what we are thinking of in particular to-night is his last expedition when he went south from the Ross Barrier and caused some 20,000 square miles of the ice-bound land round the South Pole to be photographed and geological information to be obtained with regard to the mountain ranges. It has been his ambition to lessen the unknown lands and seas round the Poles and to increase the knowledge of the parts already known. That has been his answer to the question: What more is there to discover? And it is an answer worthy of what he has shown himself to be: a man of science as well as an

intrepid explorer, a highly skilful navigator and a capable organizer, a fine product of the Annapolis School which I once visited and admired and which I am sure must be greatly proud of him.

Whereas Admiral Byrd made use of the newest aerial transport, Mr. Bertram Thomas employed the oldest of transport animals, and in other respects the work of these two Medallists was exactly opposite the one to the other, except that in both cases a great element of danger was faced and both areas explored were void of man and vegetation. Mr. Bertram Thomas would probably have preferred that the Rub' al Khali, the desert quarter of Arabia, had been more void than it was of troublesome warring and thieving Badawi tribes. It made dangerously difficult his marvellous journey of 900 miles accomplished in fifty-eight days across from the Red Sea to the Persian Gulf. Mr. Bertram Thomas follows in the wake of previous explorers of Arabia—Burton, Doughty, the Bents—in being able to tell his story well. The letters we have read in *The Times* give promise of a real epic when, in greater detail, he tells of his wonderful wanderings through waterless tracts of the desert.

Somewhat similar in its leading characteristics was the Anglo-Italian expedition of Mr. Nesbitt across part of Abyssinia. He also met with obstacles due to the hostility of natives and to the scarcity of water. In Southern Danakil the former difficulty was most felt. It is a country of ample vegetation and is fairly closely populated with tribes hostile to the European traveller. Northern Danakil, on the other hand, had little vegetation or population,and its difficulty was mainly due to lack of water. But Mr. Nesbitt successfully negotiated his journey of over 800 miles in 106 days, and was able to do so through his own and his Italian companions' pluck and energy, tact and skill. He also used the camel and the mule, and he seems to have had some contempt for what he calls "those deep parallel ruts, the spoor of the mechanical beast on virgin soil."

But such ruts were made by Mr. Beadnell in his work in Southern Libya. I think he must have got his original map from Lewis Carroll's 'Bo'sun.' He has lined it with routes, has flecked it with valuable geographical and geological notes, and has spotted it with aneroid readings, so that it is now a very useful map indeed. He has explored some 35,000 square kilometres of desert and, in addition, has earned the gratitude of future explorers and surveyors by sinking new wells where travellers would need them.

The last three of whom I have spoken have all worked where water was wanting. Colonel Rowe would rather, no doubt, have been free of the wet conditions in which much of his survey must have been done, and of the luxuriant vegetation that he had to overcome in West Africa. It is some thirty years since, I am proud to say at my instance, the Rt. Hon. Joseph Chamberlain ordered the beginning of the survey of West Africa to meet the pressing need of the delineation of the lands in the Gold Coast and Ashanti in view of the concession hunting that was then going on. It is some twenty years since Colonel Rowe began work on survey in Nigeria. Life in tropical malarial West Africa has its peculiar difficulties and dangers, and to these difficulties and dangers a surveyor is particularly exposed, but his work, besides being of great geographical value, helps the administration of the country surveyed and so adds to its well-being.

While Colonel Rowe's work was largely in assistance of administration, that of Mr. Michael Spender was entirely in aid of scientific research. He was one of the expedition of young men and women who spent a year on the Great Barrier Reef of Australia examining into those geological problems which have so greatly interested the world since Darwin, ninety years ago, wrote his book on Coral Reefs. The records of this expedition are now appearing, and it is clear that the biological work gained greatly from that of the geographical members attached

to it by this Society. Mr. Michael Spender is a very young man, and I believe he is now devoting his time to the study of stereographic survey. I have no doubt that on some future occasion when this toast is proposed his name will be at the beginning instead of at the end of the list of those His Majesty the King has delighted to honour at the instance of our Society and of those to whom the Society has made its various awards. I ask you to drink their health, and I couple with the toast the name of Mr. Bertram Thomas.

Mr. BERTRAM THOMAS: I thank you, Sir Matthew Nathan, for the very generous terms in which you have referred to my journeyings, and you, ladies and gentlemen, for the warm manner in which you have received them. And in saying this I am speaking for Admiral Byrd as well as for myself. I am only sorry that he is not here to share this ordeal with me. You will not expect me to say much about the Poles, but I may say a word about Arabia.

Arabia has been happy at least in the past in her explorers and not less happy in her annalists. The list of those who have recorded her history is not less distinguished, even if it is a short one, than the roll of early Arabian travellers. First came Ptolemy and Pliny. They had no immediate successors, and it was not until the middle of the eighteenth century that the curious eyes of Europe were again turned to the great unknown land-mass which European sailors had then been successfully circumnavigating for more than a century: though the learned D'herbelot had as early as 1697 made the West acquainted with the works of the principal Muslim geographers. The discoverer's torch was not yet lit, but the materials were ready prepared when Carsten, Niebuhr, Burkhardt, Halevy, Glazer, Burton, and Palgrave began to investigate first the edges and later the interior of the peninsula.

The arid wastes which seemed to our forefathers, in Lord Curzon's phrase, "so intrinsically abominable and vile," acquired in the eyes of Europe a fresh interest from the literary quality of the early travellers' writings. Doughty was amongst the first to give Arabia a place in the public imagination from the sheer excellence of his narrative. Next came Wyman Bury, to whose name perhaps less than justice has been done. Then followed, in our own generation, Wavell, Gertrude Bell, and Philby. In the Oman region geography owes a debt to Colonel Miles, Sir Percy Cox, and Theodore Bent; and perhaps even more to those stout-hearted marine surveyors of the forbidding coast, Wellsted, Haynes, and Constable of the old Indian Navy.

The map of the interior of Arabia owes little, if anything, to the activities of governments or to the subsidized explorations of societies. It is the work of individuals who have been animated by genuine affection for the wild but not unlovable races who have Arabia for their home and half the world as followers of their religious conceptions. If my travels help ever so little to bring fresh knowledge of Arabia and her people to light, if they suggest to the Englishman something of the virile and noble side of the Arab character, if they suggest to him that the ancient pastoral races of Arabia deserve our sympathetic study, then I shall feel that the joys of discovery are enhanced, and my labour of love more tham amply rewarded.

Sir MAURICE DE BUNSEN, in proposing the toast of the Guests, said: It has been for many years past a tradition that the Society's Annual Dinner should be graced by the presence of guests who are not numbered among the general body of geographers but whose interest spreads into other areas of life. We have this evening a very distinguished though perhaps not a very large body of guests. I can however only deal briefly with a few of them, and those whom I do not mention will, I am sure, forgive me.

In the first place, it is fitting that I should mention the presence of H.E. the

Italian Ambassador and Signora Donna Chiaramonte Bordonaro. His Excellency has already spent some years in England; certainly he has been here long enough to be well assured that love and admiration for his beautiful and noble country is enshrined in the hearts of the British people. He is accompanied by Her Excellency the Ambassadress, to whom I wish to offer, on behalf of the whole Society, a very hearty welcome indeed. Her Excellency has been amongst us only a short time, but long enough to enable her gracious and charming personality to make its way and to establish itself in the high station which belongs to her, and in circles in which she is already admired and loved. Italy is, of course, noted for achievements in geography. I am not going to attempt to enumerate them, but I cannot help referring to the presence here last year of H.R.H. the Duke of Spoleto, and we all know the name of the Duke of the Abruzzi, one of the most intrepid explorers and climbers Italy has produced. We had hoped also to see among us the Marchese and Marchesa Marconi, but they were, unfortunately, unable to reach London in time.

To pass to some of our other guests, we have also from our Diplomatic circle Prince and Princess Reginald de Croy. I used to be told in the old days when I had the honour of belonging to the profession on which they cast so much distinction that the Councillor of an Embassy was quite as important as the Ambassador himself; he was the backbone of the Embassy. I think that is often the case, and certainly Prince Reginald de Croy is well known in London as having admirably played his part as representing Belgium, together with the popular ambassadors under whom he has served, and of contributing, as also to a very large degree has Princess de Croy, to the maintenance of the very close and friendly ties which must always unite their country with ours. I had come to think and to hope that they were a permanent feature of London Society, so much beloved in London are they, but I do not know whether I am really justified in believing that. Sinister rumours have reached me that the time may come before very long when we shall lose them. If so, I hope it may only be for a short time and that they will return to the city where they are so much admired and beloved.

Before I leave our foreign guests I must just mention again, although Mr. Amery has already mentioned it, the name of Professor Holtedahl and Mrs. Holtedahl, whom we met a week ago when the Professor gave us a modest account of the hazardous journeys his countrymen and he have made around the Antarctic continent. I must also mention with pleasure the presence of Captain Galbraith, who this afternoon received, on behalf of Admiral Byrd, the Patron's Medal of the Society. We are glad to welcome Captain and Mrs. Galbraith at our table.

To come to our English guests, it is only right that I should mention, first, our former Secretary of State, Mr. Amery, to whom we have listened with so much pleasure. There is not much that I can say about him that we do not already know and appreciate. We have gathered some knowledge of the extent of his journeys throughout the world, accompanied as always by Mrs. Amery, who is a noted traveller; certainly we realize to the full their extent when we hear that he has ice capes and snowy mountains named after him in such distant areas as the Antarctic and the remote regions of the Rockies. Mr. Amery is certainly one of the statesmen on whom we rely to guide us through the difficult times in which we live in matters affecting the Empire which he has studied personally and by personal contact so well and so thoroughly.

To come now to our defensive forces, our Services, I would like to mention the pleasure it is to see present General Sir Archibald Montgomery-Massingberd and Lady Montgomery-Massingberd. After a distinguished career and after two years in the Southern Command at Salisbury, Sir Archibald has become Adjutant-General of the Forces, and after reaching that high post there is no

saying what still more exalted peaks may not lie before him to be scaled in the future. The Navy is admirably represented by Vice-Admiral Roger Backhouse, the Third Sea Lord. In the popular mind the Sea Lords are a body on whom the country relies to defend it against any undesirable encroachment on the strength of its Navy, and I know that Admiral Backhouse is one of those who from long experience would be listened to with all deference by those who go into such questions. He is very welcome here, as also is Mrs. Backhouse.

I come now to the distinguished gentlemen who represent some of our great scientific societies, and whom perhaps I should have mentioned earlier, but it is usually considered a mark of honour to reserve the more important guests to the end. We ourselves claim to be a scientific society, and therefore we welcome the guests of the brother and sister scientific societies with very special pleasure. I would especially mention the President of the Royal Society, Sir Frederick Gowland Hopkins and Lady Hopkins. I suppose there is no prouder position in the realm of science than that of President of the Royal Society. It would be impertinent on my part to attempt to enumerate even a small number of the subjects that must preoccupy Sir Frederick. I know that there is a popular feeling that may be unscientific that he was mainly concerned in inventing vitamins. Well, perhaps as Sir Frederick is going to answer this toast he may put us right about that, and also whether they should be called vitamins or vitāmina. I rather incline to the latter. Speaking seriously, Sir Frederick and Lady Hopkins are our honoured and most welcome guests this evening.

We are also exceedingly glad to welcome the new Director of the British Museum, Dr. Hill, who has quite recently succeeded Sir Frederick Kenyon, whom we all know so well. Dr. Hill, before he became Director of the British Museum, was the well-known Keeper of Coins and Medals, in which position he certainly achieved a renown that has extended far beyond the limits of our own country, for he is an authority on those matters and on many others throughout Europe. We give him a special welcome. Also I should like to mention the Director of the Royal Institution, Sir William Bragg, who has successfully conducted the centenary of the Royal Institution. We were in the same happy position last year and are very glad to see Sir William and Miss Bragg with us this evening.

I have come to the end of my list, and although I have performed my task inadequately, I can at least say that I have spoken with great sincerity in assuring our guests that we greatly enjoy their company, that we feel honoured by their presence, and that we think our Annual Dinner without them would be a comparatively poor and much less interesting affair.

Sir FREDERICK GOWLAND HOPKINS: It is a very great privilege to be allowed to respond for the Guests. In the most distinguished company present I cannot but feel my great responsibility; he who answers for the guests has more right to speak of responsibility than any other speaker, because his task is of a more representative nature. I do not propose to dwell upon my inadequacy for that task. I would rather speak of the President's responsibility for his choice of speaker, and I venture to do so because of some remarks he made not very long ago on another occasion. He then commiserated with the guests—it was quite unnecessary in that case, because he was functioning—upon their lack of remedy for bad representation, except some form of post-prandial violence upon the person of their representative! Now the object of these remarks is a plea that if the present company should be moved to act in that sense this evening, then I think the President should share my fate, and I am not sure that the Secretary should not also be one of us.

I would ask the guests whom I represent to forgive any lack of readiness in

what I have to say because of an accident that occurred at the commencement of the banquet. I sought my place at this table and found it not. My card had been prepared for the President of the Royal Academy! I am well aware that the Royal Society, unlike the Royal Academy and the Royal Geographical Society, is but little known, but I really was greatly disturbed. The President of the Royal Academy is a noted after-dinner speaker, so I thought there really had been a mistake and that my presence here and that of my wife was unjustified. However, a little investigation convinced me that there was no mistake of that sort. I am sure, Mr. President, I owe your kind invitation to respond to the toast to the fact that I represent the Royal Society, and for that I am grateful, because I think that our two Societies should always remember each other in their gatherings. They have much in common; they are both fortunate in having His Majesty as Patron, and through him they are both enabled to award to individuals their much-coveted Royal Medals. More than that, many distinguished men throughout the years have been Fellows of both. Still more: they have been associated in many enterprises. I hope the guests will forgive me for stopping to say a few words with regard to the association between these two Societies.

Before this Society came into being one hundred years ago the still older Society had the duty of encouraging geographical research; of paying honours to explorers and successful pioneers. But your Society has now long taken on that particular duty, and it does seem to me, as I have read its history, that it has done it with extraordinary efficiency throughout that history. It seems to me, indeed, that this Society is the most really active of all scientific Societies. Others among them bring their members together to listen to each other; this Society does that, but not only that: its meetings lead to action.

Recalling the time when the Royal Society had to act alone, one classical case, of course, was its very close association with the enterprises of Captain Cook; but mention of Cook reminds us of the conjoint enterprises that our two Societies have undertaken. They together erected the monument to Captain Cook at Tahiti, and they are together responsible for maintaining that monument in proper condition. As one more example, coming to much later times, you will remember that Dr. Scott's first expedition in the *Discovery* in July 1901 was an enterprise initiated jointly by the Royal Society and the Royal Geographical Society, and I have recently seen an invitation card which I can hardly refrain from quoting. On the return of that expedition a luncheon was given on 16 September 1904, and the invitation came conjointly from the Presidents of the two Societies to request the company of So-and-So at the reception of Captain Scott and the officers and men of the *Discovery* at the East India Dock and at the luncheon of welcome there. That invitation, as one looks upon the card now, awakens pathetic memories, but I hope, Mr. President, that our two Societies may yet undertake many conjoint enterprises with such worthy and noble objects and without ultimate regrets.

I must not however forget my proper duty in speaking for the guests. It is sometimes said that dinner guests are of two kinds only: the welcome guest and the unwelcome. Of the latter class I am quite sure there are none here, but I have to remember that there are, if not two classes, yet two sexes. Now, while it is not the first occasion on which I have had to respond to the toast of the guests, it is really the first time I have ever answered to that toast when ladies have been among them! I am not quite sure what points they would like me to emphasize or how they would have them put. Sir Maurice de Bunsen kindly referred to my association with certain constituents of diet and tried various forms of pronunciation. I am sorry to say that, in my opinion at least, none of them was right. I will ask him to call them vītāmīnes. You might think that my association

with such a subject might give me good reason for referring on behalf of the guests to the excellence of the material side of your dinner, but then it was a supposition, in Victorian days at least, that ladies took no interest in feasts. They were said to prefer the proverbial egg in the drawing-room. I think that however was a libel. Anyhow, what is a vītāmīne for a man is a vītāmīne for a woman, and you have provided them in abundance. I would not be so impolite as to add "What's sauce for the goose is sauce for the gander." Quoting that proverb however reminds me that I have lately read a back number of a weekly review in which the readers were set a competition involving the collection of pairs of proverbs which mutually contradict each other. The competition was interesting as showing how a little human experience can result in crystallized wisdom. I remember, at any rate, the proverb that I just dared to mention was coupled with the contradictory one that "One man's meat is another man's poison." It is a disturbing proverb for the hosts at a feast because, whatever they may provide, it would seem that some among the guests are almost certain to be for it. It is however a pessimistic proverb.

But there is another pair of contradictory proverbs: "Enough is as good as a feast," and "You cannot have too much of a good thing." It is however to the matter of those two proverbs in their unmaterial sense that I would refer. I am quite sure, Mr. President, that your guests could never have too much of that intellectual refreshment or of that truly hospitable atmosphere they find at your table. I assure you they would like to enjoy more at some later date. There is another good thing of which the world cannot have too much, and that is the growth in the membership of this great Society. I hope you will still further increase your numbers in order that your great work may develop. I feel that many of your guests to-night would like to attend as Fellows in the future.

On their behalf I have to thank the distinguished proposer of this toast for his eloquent and generous words, and the company for the kind way in which the toast was received.